COLLEGE OF ENGINEERING
THE UNIVERSITY OF WISCONSIN

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REPORT NO. 7

A SURVEY OF THE CHARACTERISTICS OF CURRENTLY USED BISTABLE MULTIVIBRATORS

by

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*Asterisk (*) indicates that circuit(s) contributed by this organization have been tested.

A SURVEY OF THE CHARACTERISTICS OF CURRENTLY USED BISTABLE MULTIVIBRATORS

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Summary--Due to the difficulty involved in the transient analysis of bistable multivibrators, an experimental investigation of the operating characteristics of a large number of currently used circuits has been carried out. Values under normal conditions as well as under a few carefully chosen perturbations are given to facilitate evaluation of the tube and circuit in actual operation. From this data it is expected that modifications in accordance with well known theory should produce a circuit to satisfy almost any particular application with a minimum of effort.

I. PURPOSE OF THE REPORT

The Eccles-Jordan type of bistable circuit, which has been variously referred to as a toggle, trigger circuit, flip-flop, lockover, or scaling circuit, is finding increasing application in digital circuitry. It is used in computers as a fast access information storage device, shift register, counter, gate control, pulse-to-static and static-to-pulse converter, and in many other ways.

The analysis of a bistable multivibrator or even the synthesis of this circuit in accordance with dc or steady-state considerations is a relatively simple matter. The transient analysis, however, which endeavors to determine the resolving time or maximum repetition rate, is much more involved. For ease of discussion, the resolving time is separated into: (1) the settling time, which is dependent on various R-C time constants and is a measure of the time which must elapse from the completion of flip-flop transition until the circuit can be successfully triggered again, and (2) the transition time which involves all the circuit elements including the tube characteristics and their associated nonlinear effects. The transition time is particularly difficult to calculate accurately, and in most cases is a by-product of the dc circuit design.

In an effort to overcome these difficulties, an attempt has been made to determine experimentally various circuit characteristics by compiling data on a number of flip-flop circuits which have been used commercially in sizable quantities by various manufacturers and universities.

A standard questionnaire was sent to 143 organizations in the United States, Canada, and England. In response to this, 88 replies were received, 58 of which comprised useful data. From over 75 circuits, 31 circuits were picked as representative, or chosen to be tested for purposes of comparison.

While it is probably true that no two flip-flop applications can be satisfied by the same optimum circuit, it is hoped that the circuits included in this report will be diverse enough to satisfy specifications approximating those desired. Modifications made to these circuits in accordance with well known theory should produce a satisfactory circuit with a minimum of effort.

2. CHOICE OF MEASUREMENTS

The measurements which have been selected to be made are listed briefly below and explained later in the text.

I. D-c Measurements
   - A. Potential of the grids in each quiescent state
   - B. Potential of the grids with tube removed
   - C. Cathode potential
   - D. Potential of the plates in each quiescent state
     1. Normal heater and dc supply voltages
     2. Heater voltage reduced 10%
     3. Heater voltage reduced 20%
     4. Positive supply voltage reduced 10%
     5. Positive supply voltage increased 10%
   - E. Current requirements of the power supplies
   - F. Tube emission with stated resistive load and B^+
     1. Heater voltage normal
     2. Heater voltage reduced 10%
     3. Heater voltage reduced 20%

II. A-c Measurements
   - A. Minimum trigger requirements with specified output load, trigger characteristics, coupling method, and repetition rate.
   - B. Rise time of output
   - C. Decay time of output
   - D. Transconductance of the tube used

The stability of a bistable circuit is of primary importance. It must remain in either of its two quiescent states indefinitely unless triggered, regardless of reasonable variations in circuit parameters and supply voltages. Initial deviation of resistance, capacitance, and tube emission from design values; subsequent changes due to aging, temperature effects, etc.; and supply voltage fluctuations due to load and line voltage changes must be allowed for in the original dc design.

Tests were made to determine the maximum variation of parameters allowable in the flip-flop used in the digital computor at the University of Wisconsin, with the results as shown in Table I. A reduction in heater voltage of the 6J6 to 4.3 volts did not produce instability in 15 samples tested. This represents an average reduction in tube emission of 22.7%.

Now these variations are much greater than those met in normal operating conditions, and since the circuits under test have presumably been in successful operation for a reasonable period of time, tests of this extreme nature were not made on all the circuits. Instead, steady state grid levels together with the cathode potential are taken to give an indication of the stability of the circuit by showing to what extent the tube is biased during cut-off, and the grid level with the tube removed is an indication of how positive the grid would become in relation to the cathode if it were unclamped by grid conduction.

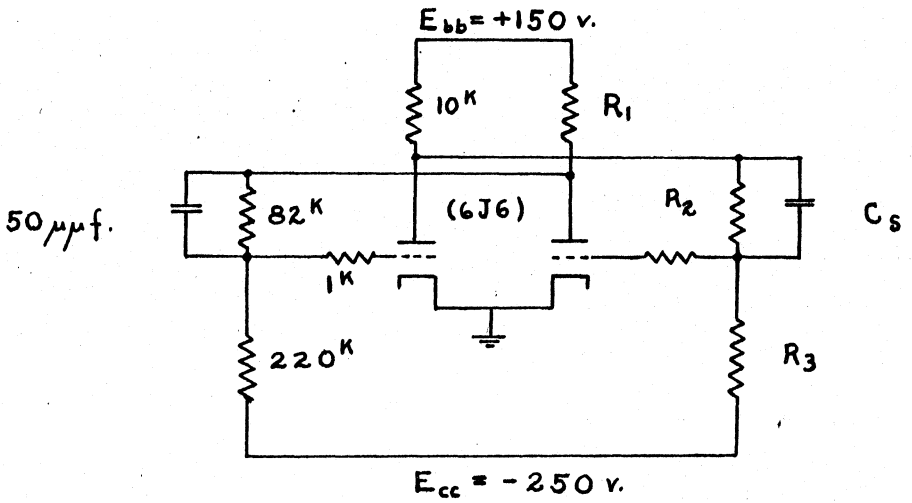
Direct measurement of the resolving time, broken down to give the transition time and the settling time, was not attempted. An arbitrary definition of the limits of each interval would be necessary and the measurement itself would be somewhat difficult to obtain. However, close approximation to the transition time is given by the rise time of the flip-flop output under stated conditions of trigger characteristic, output load, and repetition rate. The settling time is related to the maximum repetition rate of the flip-flop, consequently the circuits appearing in this report have been operated at a limiting maximum repetition rate consistent with reasonable trigger amplitudes. In general transition time and settling time cannot be minimized simultaneously.

The output voltage levels and the output voltage swing are first given under normal values of heater voltage and supply voltages. An attempt to simulate tube aging and deterioration of emission is then made by repeating these measurements with the heater voltage reduced 10% and 20% from rated values, with the hope that this data will be of aid in determining tube rejection criteria. Supply voltage fluctuations are also investigated by measuring output levels with the positive supply voltage raised and lowered 10%.

Two methods of input have been selected as representative: (1) negative triggers applied to the grids through diodes, and (2) capacitive coupling of the negative trigger to the grids. In cases where a flip-flop is used in a specific circuit function, that type of input appropriate to this function is also used. For instance if the flip-flop is used as a counter, a binary type of input is used in addition to the above listed methods.

TABLE I

Maximum Variation of Parameters



Flip-flop used in "WISC"
University of Wisconsin

R_1 (10K)		R_2 (82K)		R_3 (220K)	
Max.	Min.	Max.	Min.	Max.	Min.
53K ΔR_1 = +430%	Max. plate dissipation is exceeded before instability occurs.	120K ΔR_2 = +46.3%	47K ΔR_2 = -42.7%	360K ΔR_3 = +63.6%	150K ΔR_3 = -31.8%

E_{bb} (-150v)		E_{cc} (-250v)	
Max.	Min.	Max.	Min.
Max. plate dissipation is exceeded before instability occurs.	98v ΔE_{bb} = -34.7%	-380v ΔE_{cc} = +52 %	-149v ΔE_{cc} = -40.3%

The trigger is applied alternately to each grid of the flip-flop, thereby lessening the effect of the flip-flop transient on the trigger characteristics.

The duration of the trigger pulse was selected to be consistent with the maximum repetition rate. In some instances the trigger duration is varied at higher repetition rates, and also during tests of minimum trigger versus plate loading.

A test of the minimum trigger requirements versus trigger rise time would be of value, but this was not considered a practical measurement to be carried out for all circuits. A list of the minimum pulse amplitudes required to trigger the flip-flop listed under the "Electro-Data Corporation" is given as a general indication of what can be expected of other circuits. The values listed in Table II were obtained at a repetition rate of 200 Kc, a plate load of 14 $\mu\mu$f., a 1 μs. trigger duration, and the input coupling method illustrated.

A measurement of the minimum trigger required versus frequency is made for the two general coupling methods listed above, plus minimum trigger requirements versus the value of input coupling capacitance at a fixed frequency well within the reliable operating range of the flip-flop. Minimum trigger requirements at various output loads of combined resistance and capacitance are made to enable the type of output coupling necessary for any particular application to be determined. A value of the maximum resistive load which may be imposed on the output is not given, since in general the output amplitude and wave shape gradually deteriorate with increasing load and the maximum load permissible would necessarily be arbitrarily defined.

Since the general economy of a flip-flop is of interest, the power requirements of the dc supplies and heaters are listed.

An indication of how the tube used in the flip-flop under test compares with the average emission characteristics for that tube type is provided by measuring the plate current of the tube at zero bias with a particular resistive load and B^+. The average plate current corresponding to this value is obtained from the average plate characteristics. The load resistance and B^+ selected approximate the condition of the conducting tube in the flip-flop circuit under test.

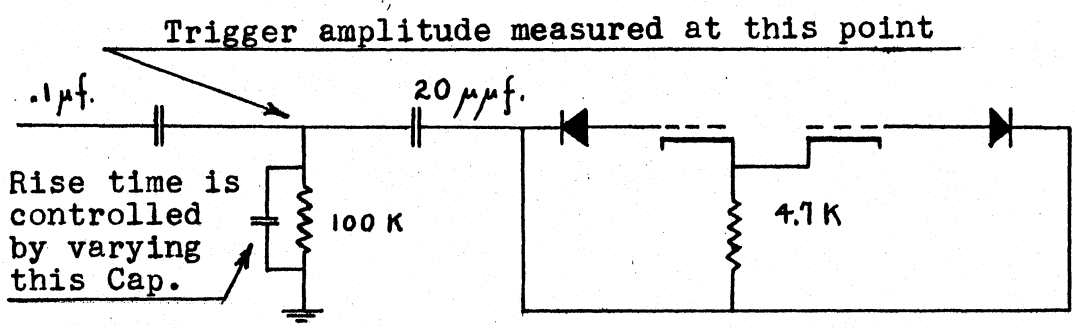
3. EQUIPMENT USED IN THE TEST

The pulse generator used as a trigger source was designed and constructed for this test, and has the following characteristics: repetition rate continuously variable over a range of 5 Kc. to 5Mc., pulse amplitude continuously variable from 1 to 150 v., pulse duration adjustable from a few tenths to over 10 microseconds, an output consisting of two series of

TABLE II

Minimum Trigger vs. Rise Time

200 Kc., 1 μs. trigger duration
plate load 10 Meg. - 14 μμf.



Rise time	Min. Trig.	Rise time	Min. Trig.
.06 us.	20 v.	.25 us.	24 v.
.08 "	20 "	.28 "	24.2 "
.13 "	20 "	.29 "	24.5 "
.16 "	21 "	.32 "	25.0 "
.18 "	21.5 "	.35 "	26.8 "
.20 "	22 "	.41 "	28.0 "
.22 "	22.8 "		

pulses displaced in phase by 180°, and a rise time of .05 – .1 microsecond. A block diagram of the pulse generator is shown together with the schematic diagram of the various blocks.

A Hewlett – Packard Model 712B oscillator is used for frequency control. The sinewave output of this generator is shaped in overdriven pentode amplifiers giving a relatively squared output. The differentiated output of two amplifiers, displaced in phase by 180°, is fed to two identical pulse generating channels. The negative spike of the differentiated square wave is used to trigger a monostable multivibrator, which determines the width of the pulse. The positive pulse from the monostable multivibrator is coupled through a cathode follower to a 6AQ5 pulse amplifier. This stage is coupled to a similar amplifier by a pulse transformer, and the output is also transformer coupled giving a choice of trigger polarity. The pulse amplitude is controlled by varying the B^+ applied to the last pulse amplifier stage.

The current in the bias supply and clamping supply is in a direction opposite to that indicated by the output terminals of these supplies, and therefore normal methods of voltage regulation are unsuitable. A cathode follower type of voltage regulation, as illustrated, is very useful for this purpose.

All measurements of dc levels were made with a calibrated vacuum tube voltmeter, having an input impedance of 11 megohms.

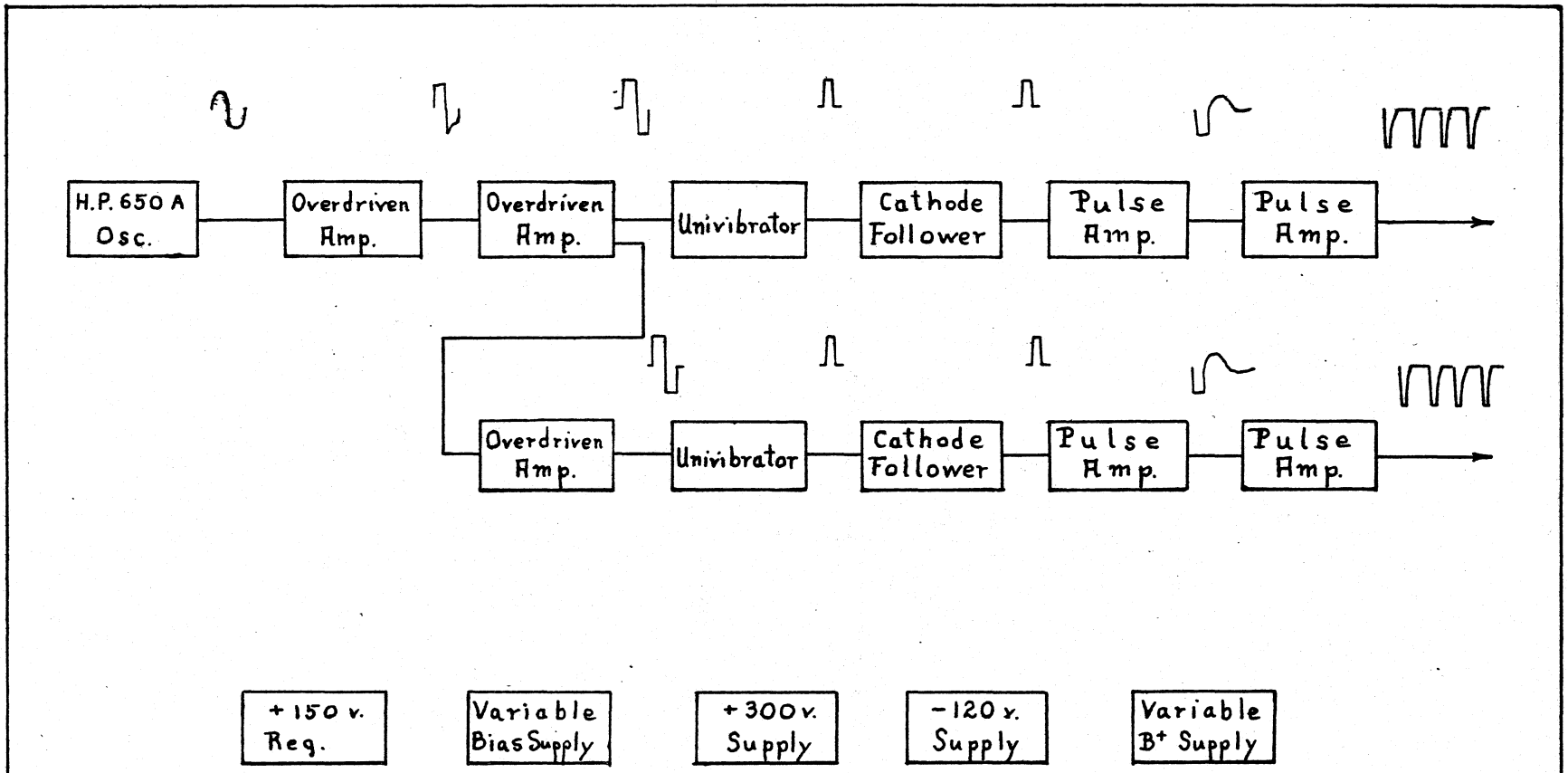
The measurements of minimum trigger amplitudes and a check on the output swing were made with a Tektronix type 535 oscilloscope. The probe of this scope places a load of 10 megohms plus 14 $\mu\mu$f. on the circuit under observation.

For the generation of trigger pulses greater than 1 μs. in duration, the circuit was modified in the following manner: Only one 6AQ5 pulse amplifier was used in each channel, .1 μf. capacitors were used to couple into this stage, the pulse transformer was replaced by a 2.2K load with the trigger being taken directly from the plate of this stage, and the variable B^+ applied to the screen grid and plate load.

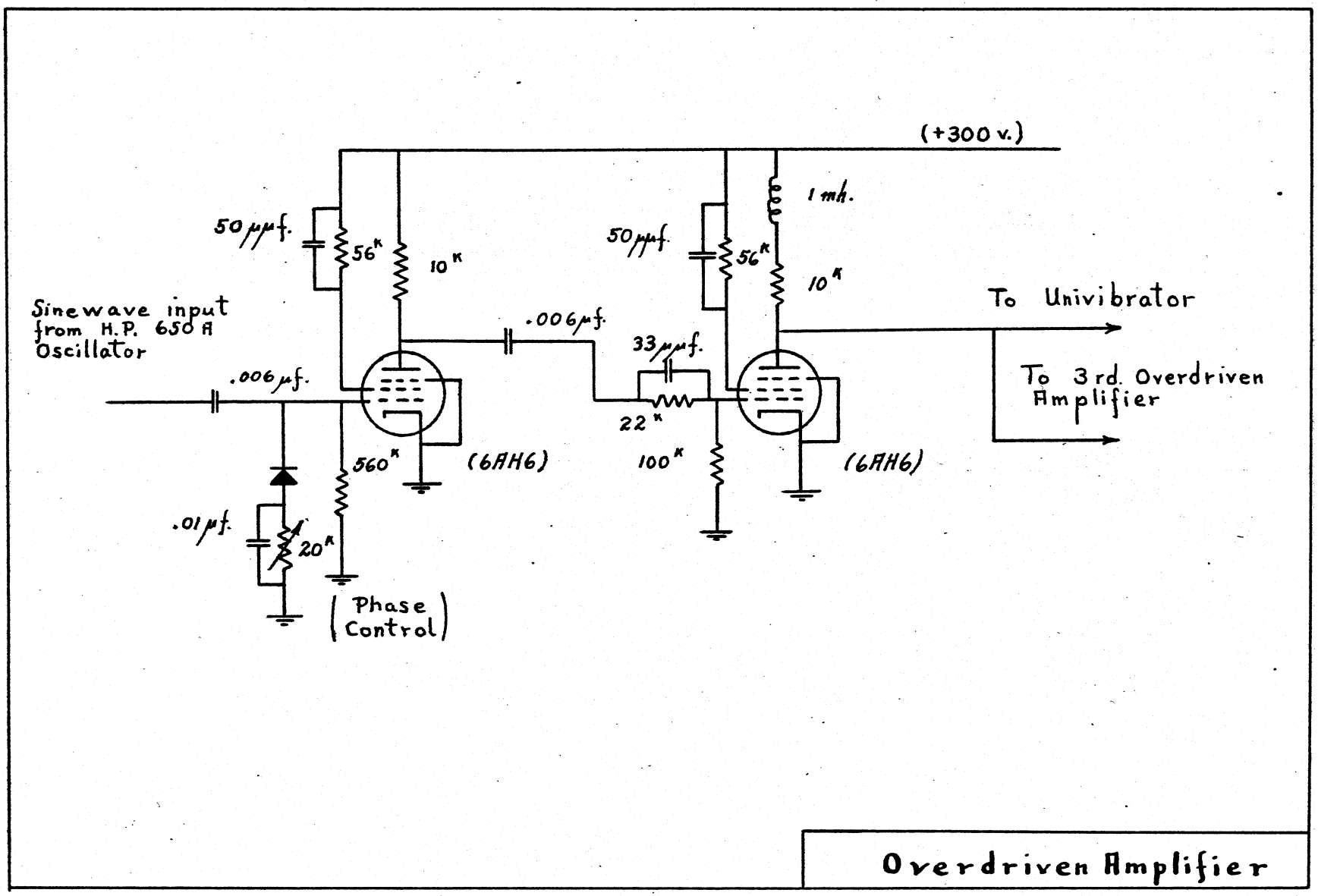
4. METHOD AND STANDARDS ADOPTED FOR THE TESTS

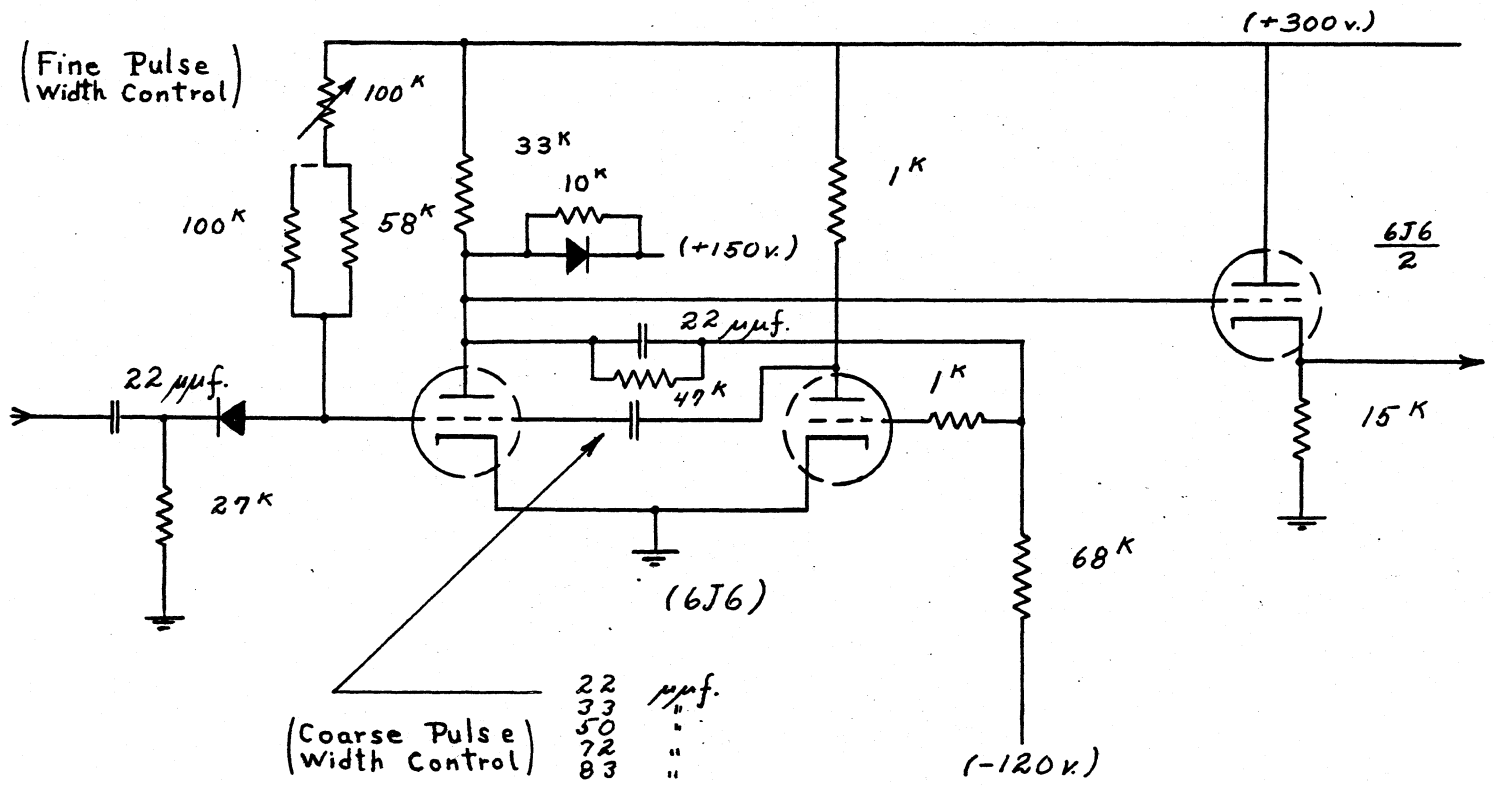
The repetition rate or frequency as referred to in this report is taken to mean the rate at which triggers are applied to the whole flip-flop circuit, which is coincident with the rate at which the flip-flop changes from one quiescent state to another. This definition is given to distinguish from the frequency of the rectangular output wave which is one half the repetition rate as defined here.

The minimum trigger for a given set of conditions is that amplitude of trigger pulse which will just bring the flip-flop into reliable operation

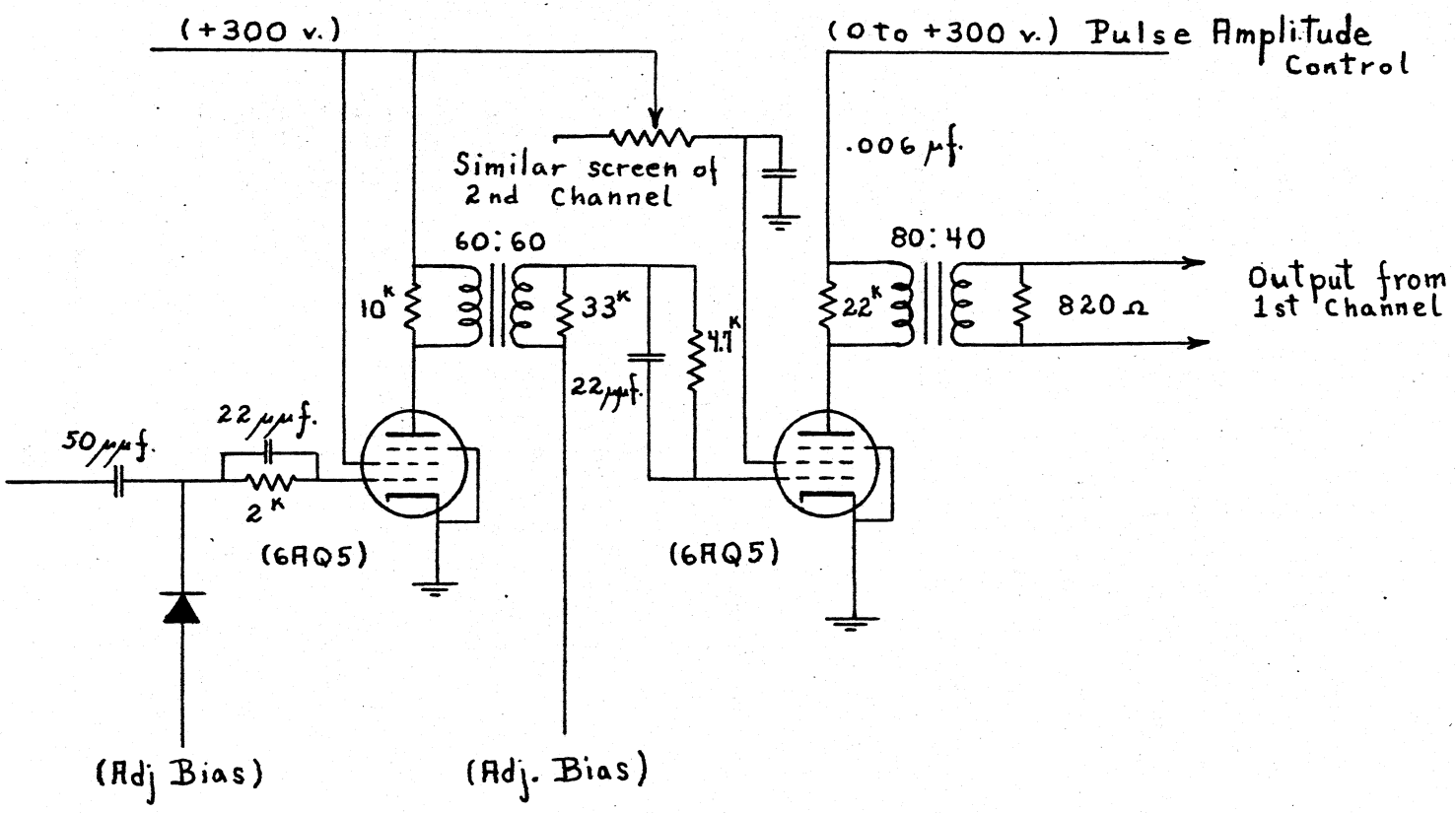


Block Diagram of Pulse generator

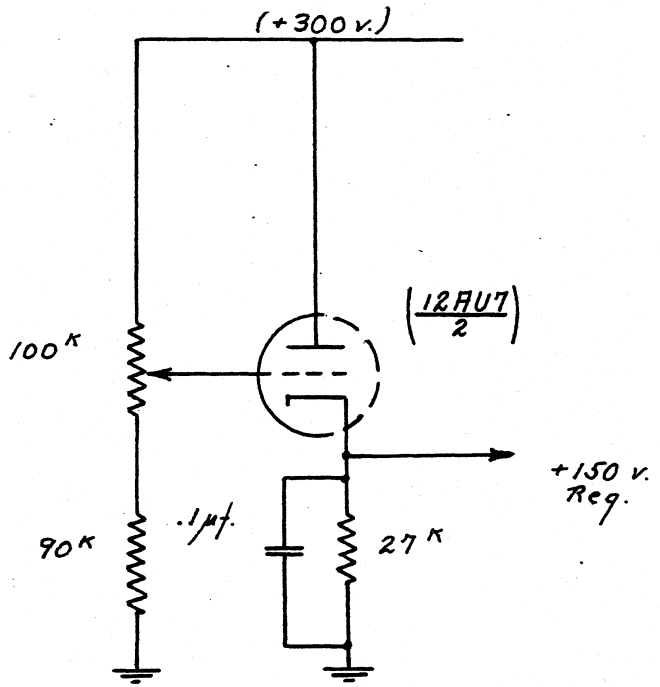

(+300 v.)
1 mh.
50 μμf.
56 K
10 K
50 μμf.
56 K
10 K
To Univibrator
Sinewave input
from H.P. 650 A
Oscillator
.006 μf.
.006 μf.
33 μμf.
To 3rd. Overdriven
Amplifier
22 K
560 K
(6AH6)
100 K
(6AH6)
.01 μf.
20 K
Phase
Control
Overdriven Amplifier



Univibrator and Cathode Follower



Pulse Amplifiers



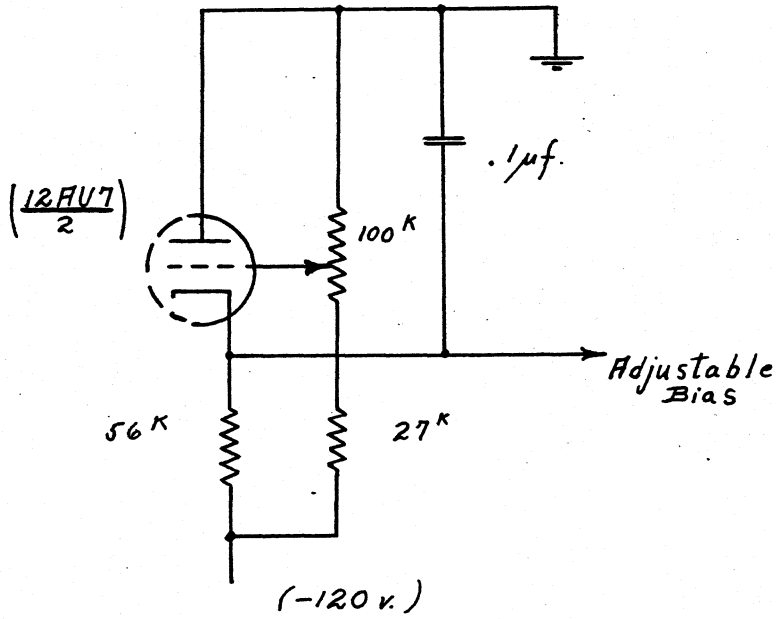


Plate Clamping and Adjustable Bias Supplies

so that the circuit changes state with each trigger as the trigger amplitude is gradually increased. In some instances, this value may be markedly greater than the trigger amplitude at which the circuit fails to operate reliably as the trigger amplitude is gradually decreased.

The output rise time is defined for purposes of this report as the interval between the instants at which the amplitude first reaches 10% and 90% of the final value as the output swings in a negative direction. From this definition, it can be seen that the instants defining the time interval are independent of overshoots or spikes which may occur in the waveform. Likewise, the decay time is taken as the interval between instants at which the amplitude last reaches 90% and 10% of the final value as the output swings positive.

The trigger is always introduced in the circuit relative to the cathode of the flip-flop and the trigger amplitudes thus are given with respect to the cathode, except for the case of plate triggering, or plate pull-over triggering. Negative triggers are used in all tests unless otherwise stated.

The resistors used in constructing the flip-flop circuits have been selected to fall within $\pm$ 1% of the nominal value. The tolerance allowed by the manufacturer or research laboratory is indicated on the schematic. The capacitor values are correct to approximately $\pm$ 1 $\mu\mu$f. except for the cathode by-pass capacitors. Regulated power supplies are used throughout, with a change of less than 50 millivolts from no load to 200 ma.

Type 1N38 diodes are used for trigger coupling and clamping; these diodes have a measured back resistance of 1 megohm.

The output points designated #1 and #2 refer to each plate of a flip-flop unless otherwise specified on the data sheet. In the event that a resistance network, split plate load, or cathode follower output is indicated, the output points are designated on the schematic accompanying each data sheet. Under tube data, #1 and #2 refer to each plate of the flip-flop tube. Each grid is also listed under grid #1 and grid #2 in the section marked "grid and cathode levels".

The value of current given for the positive flip-flop supply is the larger of two values, one measured under static conditions, the other at a repetition rate giving the largest current reading.

In general the output load imposed on the flip-flop during minimum trigger tests is 10 megohms and 14 $\mu\mu$f. at one plate or other specified output point. Several measurements of minimum trigger have been made with this load and with cathode follower output. The values of minimum trigger differ by less than two volts, therefore, the above load of 10 megohms and 14 $\mu\mu$f. was used in all cases whether cathode follower output was indicated or not.

ACKNOWLEDGMENTS

The authors are grateful for the support extended by the Engineering Experiment Station, College of Engineering, University of Wisconsin, and by the manufacturers and research organizations which have so generously contributed information enabling compilation of this survey. We regret that some circuits have been omitted from this report due to limitations of time and equipment.

In the following data pages, supplementary information regarding a circuit or its operation has been placed on the facing page.

Binary Type Coupling

Freq.	Min. Trig.	Dur.
20 Kc.	8.8 v.	1 μs.
30	8.8	
40	8.6	
70	8.6	
100	8.6	
200	8.8	
300	8.8	
400	8.8	
500	10.0	
600	16.0	
800	23.	

INPUT	DIODE COUPLING FREQ.	MIN. TRIG.	DUR.	CAPACITIVE COUPLING 30 UUF FREQ.	MIN. TRIG.	DUR.	200 Kc. TRIGGER C_c	MIN. TRIG.	DUR.	C_c = 30 UUF ~~PLATE LOAD~~ MIN. TRIG.
	20 Kc.	2.5 V.	1 μs.	20 Kc.	6.0 V.	1 μs.	10 μμf.	12.4 v.	1 μs.	Load at Output #1
	30	2.6		30	6.0		30 "	6.8		100 K, 50 μμf. 7. v. (1 μs. dur.)
	40	2.6		40	6.4		50 "	6.0		100 K, 100 μμf. 7. v. (1 μs. dur.)
	70	2.8		70	6.4		100 "	5.6		100 K, 185 μμf. 8.4 v. (1 μs. dur.)
	100	3.0		100	6.4					
	200	3.6		200	6.8					
	300	4.5		300	6.8					
	400	5.6		400	8.0					
	500	6.4		500	10.4					
	600	7.2		600	14.0					
	800	17.0		800	17.0					
	1 Mc.	25.		1 Mc.	20.0					
	1.5	50.		← 23 v. swing at output #1						

OUTPUT	Nominal #1	Nominal #2	ΔE_F = − 10 % #1	ΔE_F = − 10 % #2	ΔE_F = − 20 % #1	ΔE_F = − 20 % #2	ΔE_{BB} = − 10 % #1	ΔE_{BB} = − 10 % #2	ΔE_{BB} = + 10 % #1	ΔE_{BB} = + 10 % #2
FLIP	267	200	267	200	268	200	240	179	292	215
FLOP	292	271	292	271	292	271	262	243	320	293
SWING	25	71	25	71	24	71	22	64	28	78

COMMENTS: The Output #1 and #2 refer to the points shown on the schematic.
Minimum Trigger tests made with 14 μμf. load at Output #1

DATA: (TUBE USED IN TEST)

	#1	#2
G_M	2250	2300

EMISSION WITH 10 K LOAD
E_{BB} = 170 v., E_C = 0 v.

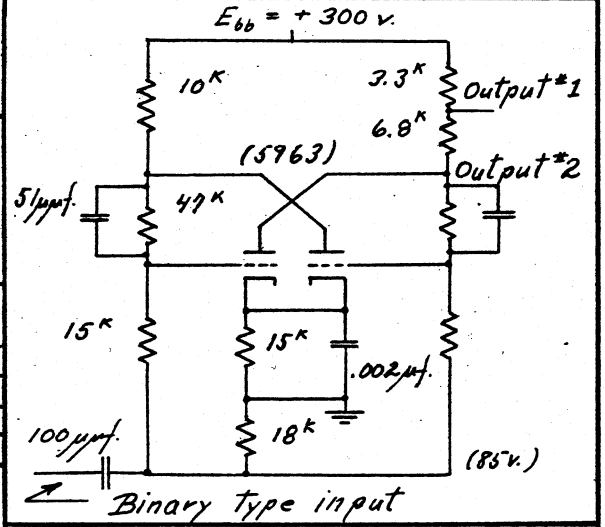
ΔE_F	#1	#2
0	9.1 ma.	9.4 ma.
− 10 %	9.0 "	9.1 "
− 20 %	8.8 "	8.9 "

EMISSION AS ABOVE TAKEN FROM AVERAGE 5963 TUBE CHARACTERISTIC
9.1 MA.

CIRCUIT DATA: POWER REQUIREMENTS:
+300 v. Supply 13. ma.
6.3 " " 300 "

GRID AND CATHODE LEVELS	#1	#2	K	#1	#2	K
TUBE IN PLACE	130	112	130			
	111	130	130			
TUBE REMOVED	140					
		140				

(200 Kc., 14 μμf. load, 10 v. Trigger)
OUTPUT #1 RISE TIME (NEG. GOING) .13 μs
DECAY TIME (POS. GOING) 1.0 μs
Output #2 Rise Time .13 μs.
Decay Time 1.3 μs.



Use: Binary Decade Scaler

Austin Company

INPUT	DIODE COUPLING FREQ.	MIN. TRIG.	DUR.	CAPACITIVE COUPLING 30 µµf FREQ.	MIN. TRIG.	DUR.
	20 Kc.	4.0 v.	1µs.	20 Kc.	8.6 v.	1µs.
	30	4.0		30	8.6	
	40	4.2		40	9.0	
	70	4.6		70	9.0	
	100	5.5		100	9.5	
	200	7.		200	10.6	
	300	8.		300	14.0	
	400	10.		400	17.	
	500	12.		500	19.	
	600	16.		600	22.	
	800	27.		800	25.	
	1 Mc.	38.		1 Mc.	28.	

200 Kc. TRIGGER

C_G	MIN. TRIG.	DUR.
10 µµf.	20 v.	1. µs.
30 "	10.6 "	
50 "	8.8 "	

C_G = 30 µµf

PLATE LOAD	MIN. TRIG.
100K, 50 µµf.	13 v. (1 µs. dur.)
100K, 100 µµf.	16 v. (1 µs. dur.)
100K, 185 µµf.	20 v. (1 µs. dur.)

100K, 185 µµf. at Output #1 does not affect Min. Trig. or Output #1 swing.

OUTPUT	Nominal #1	Nominal #2	Diodes Removed #1	Diodes Removed #2	ΔE_F = −10 % #1	ΔE_F = −10 % #2	ΔE_F = −20 % #1	ΔE_F = −20 % #2	ΔE_{BB} = −10 % #1	ΔE_{BB} = −10 % #2	ΔE_{BB} = +10 % #1	ΔE_{BB} = +10 % #2
FLIP	-20.5	-63	-103	-122	-103	-122	-103	-122	-105	-125	-101	-120
FLOP	+.3	-5	24	17	24	17	24	17	15	9	30	23
SWING	20.8	58	127	139	127	139	127	139	120	132	131	143

(Diodes Removed)

COMMENTS: Output #1 and #2 refer to points shown on schematic. With the output clamping diodes in place, The output levels change less than 1 v. for ΔE_f = −20% and ΔE_{bb} = ±10%.

DATA: (TUBE USED IN TEST)

	#1	#2
G_M	6600	6300

EMISSION WITH 43 K LOAD

E_{BB} = 220 v., E_C = 0 v.

ΔE_F	#1	#2
0	4.3 ma.	4.2 ma.
-10 %	4.1 "	4.1 "
-20 %	4.0 "	4.0 "

EMISSION AS ABOVE TAKEN FROM AVERAGE 5965 TUBE CHARACTERISTIC 4.2 MA.

CIRCUIT DATA: POWER REQUIREMENTS:

+100 v. Supply	5.5 ma.
−160 v. "	13.2 "
6.3 v. "	450. "

GRID AND CATHODE LEVELS	#1	#2	K	Diodes Removed #1	Diodes Removed #2	Diodes Removed K
TUBE IN PLACE	-117	-129	-117	-135	-148	-135
	-130	-117	-117	-148	-135	-135
TUBE REMOVED	-111			-103		
		-111			-103	

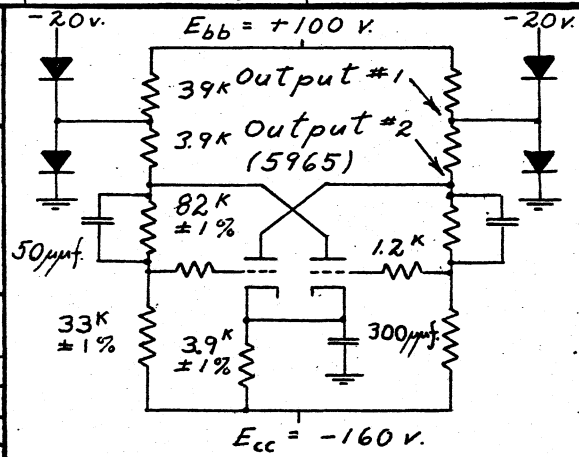
(200 Kc, 14 µµf. load, 12 v. Trigger)

OUTPUT #1 RISE TIME (NEG. GOING) .06 µs

DECAY TIME (POS. GOING) 1.0 µs

Output #2 Rise time .13 µs.

Decay time 1.4 µs.



Res. are 5% except as noted

Bendix Computer Division

Bendix Aviation Corp.

Binary Type Coupling					
Freq.		Min. Trig.		Dur.	
20	Kc.	24.	V.	2	μs.
30		24.			
40		24.			
60		26.			
80		32.			
100		38.			
150		52.			
200		66.			
250		100.			

INPUT	DIODE COUPLING FREQ.	MIN. TRIG.	DUR.	CAPACITIVE COUPLING 30 μμF FREQ.	MIN. TRIG.	DUR.	100 Kc TRIGGER (.1 μs Rise time) C_c	MIN. TRIG.	DUR.	C_c = 30 μμF PLATE LOAD	MIN. TRIG.
	20 Kc.	1.8 V.	2 μs.	20 Kc.	8.6 V.	2 μs.	10 μμf.	36. v.	2 μs.	100K, 50 μμf.	20 v. (2 μs. dur.)
	30	1.8		30	8.8		30 "	21		68V. plate swing	
	40	2.0		40	11.4		50 "	15		100K, 100 μμf.	23v. (2 μs. dur.)
	60	2.0		60	12.		100 "	11.4		100K, 185 μμf.	will not change state with 150v. trigger.
	80	2.5		80	16.						
	100	3.		100	21.						
	150	5.		150	33.						
	200	8.		200	38.						
	300	17.		300	44.						
	400	29.		400	50.						
	500	44.		500	52.						

← 100 v. plate swing

OUTPUT	Nominal #1	Nominal #2	ΔE_F = −10 % #1	ΔE_F = −10 % #2	ΔE_F = −20 % #1	ΔE_F = −20 % #2	ΔE_{BB} = −10 % #1	ΔE_{BB} = −10 % #2	ΔE_{BB} = +10 % #1	ΔE_{BB} = +10 % #2
FLIP	64	175	65	175	65	175	59	158	70	192
FLOP	175	64	175	65	175	65	158	58	192	70
SWING	111	111	110	110	110	110	99	100	122	122

COMMENTS: For binary type coupling see reverse side of data sheet.

DATA: (TUBE USED IN TEST)

	#1	#2
G_M	2250	2300

EMISSION WITH 42 K LOAD

E_{BB} = 160 v., E_C = 0 v.

ΔE_F	#1	#2
0	3.1 ma.	3.1 ma.
−10 %	3.0 "	3.0 "
−20 %	3.0 "	3.0 "

EMISSION AS ABOVE TAKEN FROM AVERAGE 5963 TUBE CHARACTERISTIC 3.1 MA.

CIRCUIT DATA: POWER REQUIREMENTS:

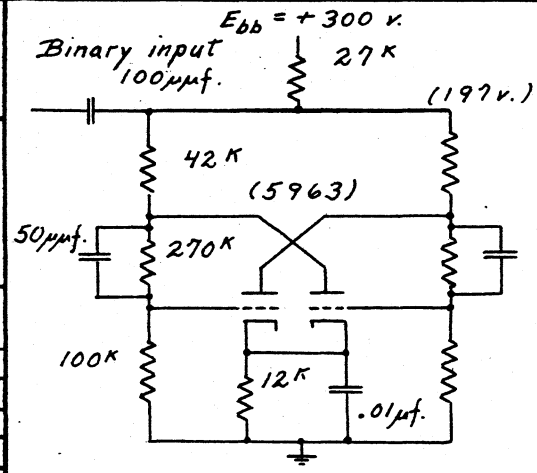
+300 v. Supply 4.0 ma.
6.3 - " 300. "

GRID AND CATHODE LEVELS	#1	#2	K	#1	#2	K
TUBE IN PLACE	38	17	38			
	17	38	38			
TUBE REMOVED	64					
		64				

(100 Kc., 14 μμf plate load, 6v. trigger)

OUTPUT: RISE TIME (NEG. GOING) .42 μs

DECAY TIME (POS. GOING) 5.4 μs



Resistor tolerances ±5%

Berkeley Division
Beckman Instruments, Inc.

INPUT	DIODE COUPLING FREQ.	MIN. TRIG.	DUR.	CAPACITIVE COUPLING 30 UUF FREQ.	MIN. TRIG.	DUR.
	20 Kc.	3.4 v.	1 μs.	20 Kc.	15. v.	1 μs.
	40	3.6		40	15.	
	70	4.0		70	15.	
	100	4.0		100	15.	
	200	4.6		200	15.	
	400	8.		400	16.	
	600	12.		600	21.	
	800	20.		800	22.	
	1 Mc.	30.		1 Mc.	22.	
	50 v. plate swing			1.5	22.	
				(36 v. plate swing)		

200 Kc. TRIGGER (.05 μs. Rise time)

C_G	MIN. TRIG.	DUR.
10 μμf.	28. v.	1 μs.
	27.	2 "
30 "	15.	1 "

C_G = 30 UUF

PLATE LOAD	MIN. TRIG.
100 K, 50 μμf.	88 v. (1 μs. dur.)
" "	35 v. (2 μs. dur.)
100 K, 100 μμf.	72 v. (2 μs. dur.)

OUTPUT	Nominal #1	Nominal #2	ΔE_F = −10 % #1	ΔE_F = −10 % #2	ΔE_F = −20 % #1	ΔE_F = −20 % #2	ΔE_{BB} = −10 % #1	ΔE_{BB} = −10 % #2	ΔE_{BB} = +10 % #1	ΔE_{BB} = +10 % #2
FLIP	110	163	110	163	111	163	100	147	121	180
FLOP	163	111	163	111	163	112	147	101	180	122
SWING	53	52	53	52	52	51	47	46	59	58

COMMENTS: For comparison of a similar circuit using a Type 5963 tube see F.F. of Electro Data Corp.

DATA: (TUBE USED IN TEST)

	#1	#2
G_M	3080	3150

EMISSION WITH 12 K LOAD

E_{BB} = 140 v.; E_C = 0 v.

ΔE_F	#1	#2
0	6.7 ma.	6.8 ma.
−10 %	6.6 "	6.7 "
−20 %	6.4 "	6.5 "

EMISSION AS ABOVE TAKEN FROM AVERAGE 12AU7 TUBE CHARACTERISTIC

6.3 MA.

CIRCUIT DATA: POWER REQUIREMENTS:

+200 v. Supply 10.3 ma.

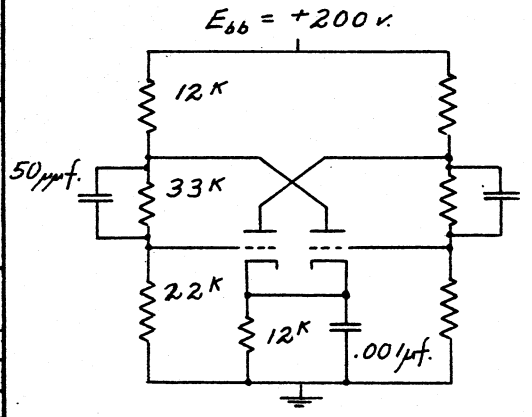
6.3 " " 300. "

GRID AND CATHODE LEVELS	#1	#2	K	#1	#2	K
TUBE IN PLACE	64	43	64			
	44	64	64			
TUBE REMOVED	65					
		65				

(200 Kc, 14 μμf. plate load, 10 v. Trigger)

OUTPUT: RISE TIME (NEG. GOING) .22 μs

DECAY TIME (POS. GOING) 1.3 μs



Deposited-carbon resistors ±1%

Use: Computer

Univ. of California

INPUT	DIODE COUPLING			CAPACITIVE COUPLING 30 UUF			200 Kc. TRIGGER (.05 μs. Rise time)			C_c = 30 UUF
	FREQ.	MIN. TRIG.	DUR.	FREQ.	MIN. TRIG.	DUR.	C_c	MIN. TRIG.	DUR.	PLATE LOAD MIN. TRIG.
	20 Kc.	3.0 v.	1 μs.	20 Kc.	12 v.	1 μs.	10 μμf.	22 v.	2 μs.	100K, 50 μμf. 80 v. (1 μs. dur.)
	40	3.3		40	12			23	1	32 v. (2 μs. dur.)
	70	3.6		70	12		30	12	1	
	100	4.0		100	12					100K, 100 μμf. 72 v. (2 μs. dur.)
	200	4.2		200	12					
	400	6.6		400	13					
	600	9.4		600	16					
	800	15.		800	18					
	1 Mc.	21.		1 Mc.	19					
	(44 v. plate swing)			1.5	19					
				(35 v. plate swing)						

OUTPUT	Nominal #1	Nominal #2	ΔE_F = −10 % #1	ΔE_F = −10 % #2	ΔE_F = −20 % #1	ΔE_F = −20 % #2	ΔE_{BB} = −10 % #1	ΔE_{BB} = −10 % #2	ΔE_{BB} = +10 % #1	ΔE_{BB} = +10 % #2
FLIP	111	163	112	163	112	163	100	146	123	179
FLOP	163	112	163	113	163	114	146	102	179	125
SWING	52	51	51	50	51	49	46	44	56	54

COMMENTS: For comparison of similar circuits using tube types 12AU7 and 5963 see FF's of the Univ. of Calif. and Electro Data Corp.

DATA: (TUBE USED IN TEST)

	#1	#2
G_M	4250	4200

EMISSION WITH 12 K LOAD

E_{BB} = 140 v., E_C = 0 v.

ΔE_F	#1	#2
0	6.3 ma.	6.3 ma.
−10 %	5.9 "	5.9 "
−20 %	5.4 "	5.4 "

EMISSION AS ABOVE TAKEN FROM AVERAGE 12AT7 TUBE CHARACTERISTIC 5.8 MA.

CIRCUIT DATA: POWER REQUIREMENTS:

+200 v. Supply 10 ma.

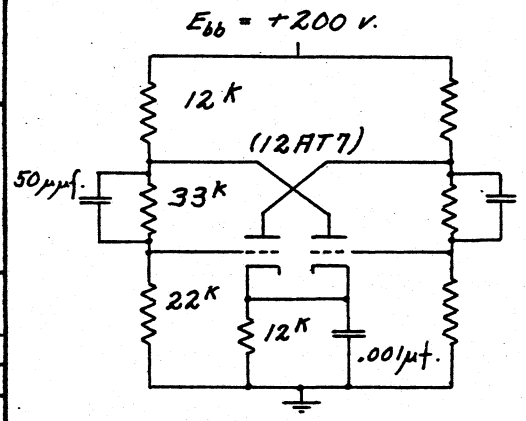
6.3 v. " 300 "

GRID AND CATHODE LEVELS	#1	#2	K	#1	#2	K
TUBE IN PLACE	62	45	62			
	44	63	63			
TUBE REMOVED	65					
		65				

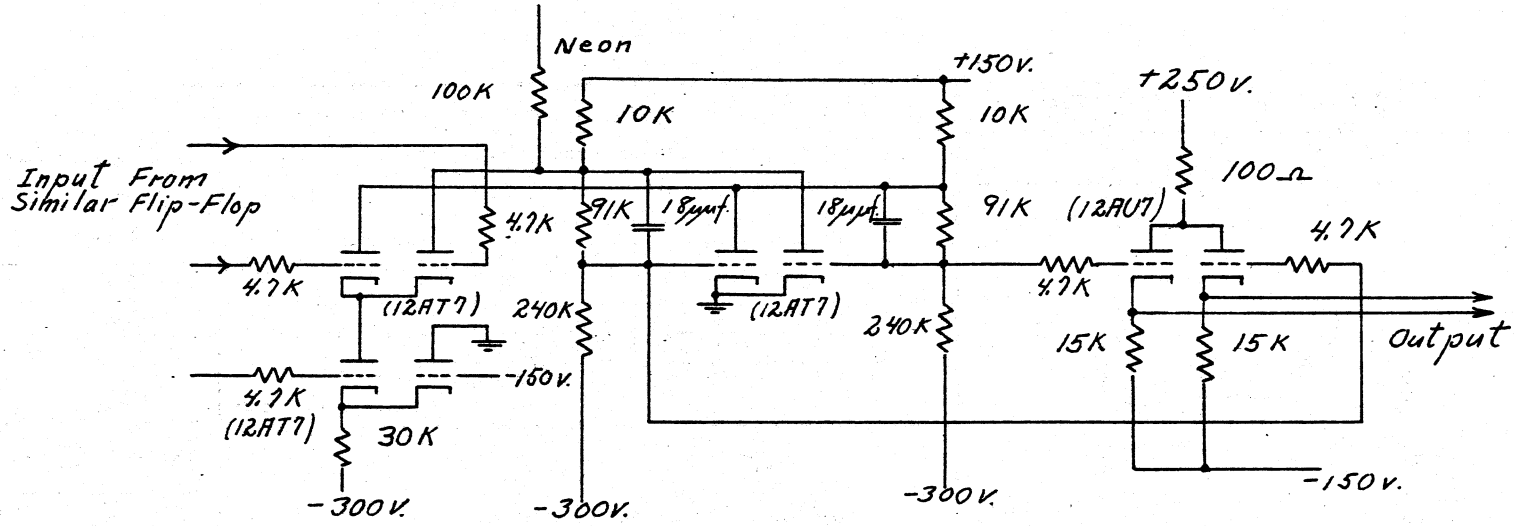
OUTPUT: RISE TIME (NEG. GOING) .24 μs

DECAY TIME (POS. GOING) 1.4 μs

(200 Kc., 14 μμf. plate load, 10 v. Trigger)



Comparison Circuit


Neon
100K
10K
+150V.
10K
+250V.
100Ω
Input From
Similar Flip-Flop
4.7K
91K
18μμf
18μμf
91K
(12AU7)
4.7K
4.7K
(12AT7)
240K
(12AT7)
240K
4.7K
15K
15K
Output
-150V.
4.7K
(12AT7)
30K
-300V.
-300V.
-300V.
-150V.

INPUT	DIODE COUPLING FREQ.	MIN. TRIG.	DUR.	CAPACITIVE COUPLING 10 μμF FREQ.	MIN. TRIG.	DUR.	200 Kc. TRIGGER (.05 μs. Rise time) C_G	MIN. TRIG.	DUR.	PLATE LOAD	MIN. TRIG.
	20 Kc.			20 Kc.	50 v.	2.4 μs.					
	40	2.5 v.	.7 μs.	40	49		10 μμf.	45. v.	2.4 μs.	100K, 25 μμf.	66 v. (2.2 μs. dur.)
	70	2.5		70	49						
	100	4.0		100	48		15	36	2.4	100K, 50 μμf. — will not trigger with an input signal of 170 v., 2.4 μs dur.	
	200	4.8		200	45						
	400	8.		400	38						
	600	13.		600	38	1.3 μs.					
	800	17.		800	38						
	1 Mc.	24.		1 Mc.	40						
(67 v. plate swing)											

OUTPUT	Nominal #1	Nominal #2	ΔE_F = −10 % #1	ΔE_F = −10 % #2	ΔE_F = −20 % #1	ΔE_F = −20 % #2	ΔE_{BB} = −10 % #1	ΔE_{BB} = −10 % #2	ΔE_{BB} = +10 % #1	ΔE_{BB} = +10 % #2
FLIP	66	137	67	137	72	137	64	122	70	149
FLOP	136	67	136	69	136	75	122	65	148	71
SWING	70	70	69	68	64	62	58	57	78	78

COMMENTS: For complete circuit as used in EDSAC II see reverse side of data sheet.

DATA: (TUBE USED IN TEST)

	#1	#2
G_M	4400	4300

EMISSION WITH 10 K LOAD E_{BB} = 150 v., E_C = 0 v.

ΔE_F	#1	#2
0	7.5 ma.	7.5 ma.
−10 %	7.0 "	7.0 "
−20 %	6.4 "	6.0 "

EMISSION AS ABOVE TAKEN FROM AVERAGE 12AT7 TUBE CHARACTERISTIC 6.8 MA.

CIRCUIT DATA: POWER REQUIREMENTS:

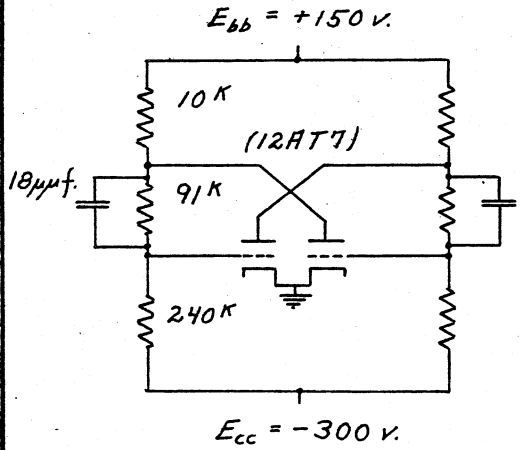
+150 v. Supply	9.8 ma.	
−300 v. "	2.2 "	
6.3 v. "	300. "	

GRID AND CATHODE LEVELS	#1	#2	K	#1	#2	K
TUBE IN PLACE	0	−34	0			
	−34	0	0			
TUBE REMOVED	+17					
		+18				

OUTPUT: RISE TIME (NEG. GOING) .25 μs

DECAY TIME (POS. GOING) .85 μs

(200 Kc., 14 μμf plate load, 10 v. Trigger)



Resistors are ± 5 %

Used in: EDSAC II

Univ. Math. Lab., Cambridge, England

INPUT	DIODE COUPLING FREQ.	MIN. TRIG.	DUR.	CAPACITIVE COUPLING 30 μμF FREQ.	MIN. TRIG.	DUR.	40 Kc. TRIGGER (C_G)	MIN. TRIG.	DUR.
	20 Kc.	10. v.	3 μs.	20 Kc.	14. v.	3 μs.	10 μμf.	57 v.	3 μs.
	30	11.		30	20.		30	30	
	40	14.		40	30.		50	25	
	70	20.		70	52.				
	100	27.		100	68.				
	150	38.		150	92.				
	200	52.		200	104.				

(.1 μs. Rise time) C_c = 30 μμF

PLATE LOAD	MIN. TRIG.
100K, 50 μμf.	31 v. (3 μs. dur.)
100K, 100 μμf.	36 v. (3 μs. dur.)
100K, 185 μμf.	45 v. (3 μs. dur.)

OUTPUT	Nominal #1	Nominal #2	ΔE_F = −10 % #1	ΔE_F = −10 % #2	ΔE_F = −20 % #1	ΔE_F = −20 % #2	ΔE_{BB} = −10 % #1	ΔE_{BB} = −10 % #2	ΔE_{BB} = +10 % #1	ΔE_{BB} = +10 % #2
FLIP	76	192	77	192	77	192	69	174	84	211
FLOP	193	73	193	73	193	74	174	67	211	81
SWING	117	119	116	119	116	118	105	107	127	130

COMMENTS:

DATA: (TUBE USED IN TEST)

	#1	#2
G_M	2300	2350

EMISSION WITH 27 K LOAD

E_{BB} = 170 v., E_C = 0 v.

ΔE_F	#1	#2
0	4.7 ma.	4.6 ma.
−10 %	4.6 "	4.5 "
−20 %	4.5 "	4.4 "

EMISSION AS ABOVE TAKEN FROM AVERAGE 5963 TUBE CHARACTERISTIC 4.6 MA.

CIRCUIT DATA: POWER REQUIREMENTS:

+200 v. Supply 5.0 ma.

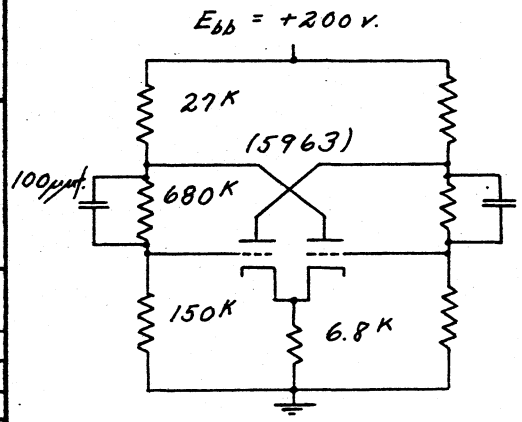
6.3 v. " 300. "

GRID AND CATHODE LEVELS	#1	#2	K	#1	#2	K
TUBE IN PLACE	31	13	31			
	13.5	32	32			
TUBE REMOVED	34					
		34				

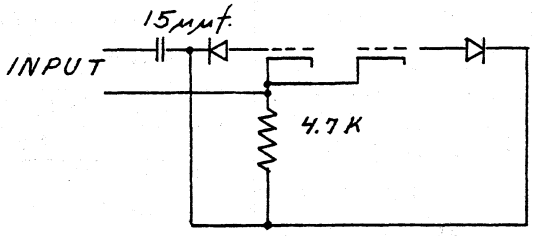
OUTPUT: RISE TIME (NEG. GOING) .8 μs

DECAY TIME (POS. GOING) 6.8 μs

(40 Kc, 14 μμf. plate load, 30 v. trigger)



Clevite-Brush Development Co.



BINARY TYPE COUPLING		
Freq.	Min. Trig.	Dur.
10 Kc.	24 v.	1 μs.
20	24.	
40	25.	
70	25.	
100	27.	
200	27.	
400	28.	
500	29.	
600	36.	
800	40.	
1 Mc.	50.	

INPUT	DIODE COUPLING FREQ.	MIN. TRIG.	DUR.	CAPACITIVE COUPLING 30 UUF FREQ.	MIN. TRIG.	DUR.
	20 Kc.	3.2 v.	1 μs.	20 Kc.	18. v.	1 μs.
	70	3.2		30	18.	
	100	3.8		40	20.	
	200	6.0		70	20.	
	300	7.2		100	20.	
	400	9.6		200	20.	
	500	13.		400	18.	
	600	15.		500	18.	
	800	19.		600	17.	
	1 Mc.	27.		700	17.	
	(76 v. plate swing)			800	17.	
	1	23.	.5 μs.	1 Mc.	17.	
	1.5	43.		1.5	17.	
	2.0	66. (7 μμf plate load)				

200 Kc. TRIGGER (.05 - 1 μs. Rise time) C_c = 30 UUF

C_c	MIN. TRIG.	DUR.
10 μμf.	35 v.	1 μs.
20	22	
30	20	

PLATE LOAD	MIN. TRIG.
100K, 50 μμf.	100 v. (1 μs. dur.)
100K, 50 μμf.	32 v. (2 μs. dur.)

43 to 68 v. circuit flips twice per trigger pulse. For trig. amp. > 68 v. operation normal.

OUTPUT	Nominal #1	Nominal #2	ΔE_F = -10 % #1	ΔE_F = -10 % #2	ΔE_F = -20 % #1	ΔE_F = -20 % #2	ΔE_{BB} = -10 % #1	ΔE_{BB} = -10 % #2	ΔE_{BB} = +10 % #1	ΔE_{BB} = +10 % #2
FLIP	148	225	148	225	149	225	135	203	166	249
FLOP	225	146	225	148	225	149	203	134	249	164
SWING	77	79	77	77	76	76	68	69	83	85

COMMENTS: For Binary type coupling see reverse side of data sheet.

DATA: (TUBE USED IN TEST)

	#1	#2
G_M	2250	2300

EMISSION WITH 10 K LOAD

E_{BB} = 160 v., E_C = 0 v.

ΔE_F	#1	#2
0	8.6 ma.	8.6 ma.
-10 %	8.4 "	8.4 "
-20 %	8.2 "	8.2 "

EMISSION AS ABOVE TAKEN FROM AVERAGE 5963 TUBE CHARACTERISTIC

8.5 MA.

CIRCUIT DATA: POWER REQUIREMENTS:

+250 v. Supply 12.2 ma.

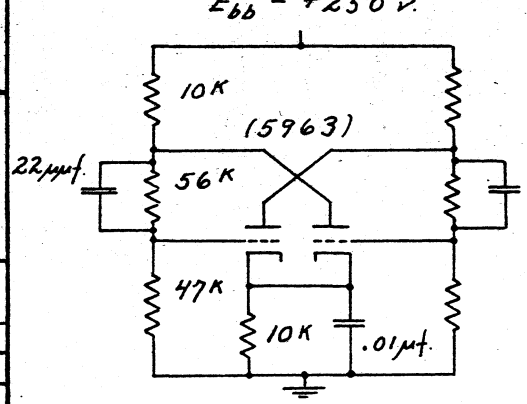
6.3 v. " 300. "

GRID AND CATHODE LEVELS	#1	#2	K	#1	#2	K
TUBE IN PLACE	92	67	92			
	67	93	92			
TUBE REMOVED	102					
		102				

OUTPUT: RISE TIME (NEG. GOING) .17 μs

DECAY TIME (POS. GOING) .94 μs

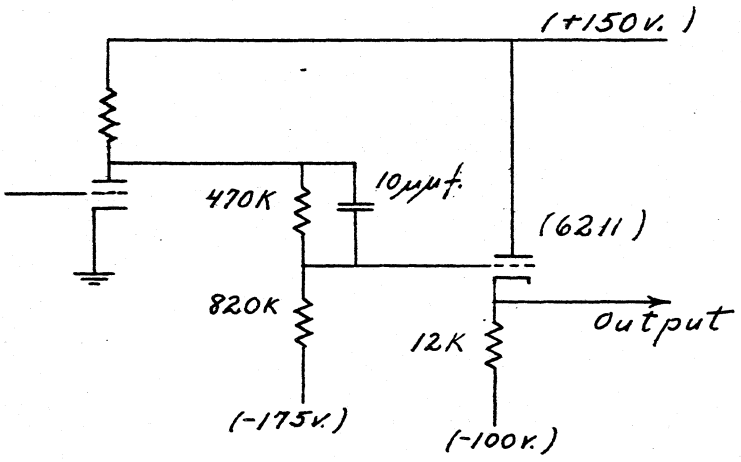
(200 Kc., 14 μμf. plate load, 10 v. trigger)



Resistor tol. ± 5 %

MilliSadic Data Handling Systems

Consolidated Engineering Corp.


(+150v.)
470K
10μμf.
(6211)
820K
Output
12K
(-175v.)
(-100v.)

INPUT	DIODE COUPLING FREQ.	MIN. TRIG.	DUR.	CAPACITIVE COUPLING 30 μμF FREQ.	MIN. TRIG.	DUR.	100 Kc. TRIGGER (.1-.05 μs. Rise time) C_c	MIN. TRIG.	DUR.	C_c = 30 μμF PLATE LOAD	MIN. TRIG.
	20 Kc.	2.0 v.	1 μs.	20 Kc.	12. v.	1 μs.	10 μμf.	44. v.	1 μs.	100K, 50 μμf.	24 v. (1 μs. dur.)
	30	2.0		30	13.		25	22.		100K, 100 μμf.	25 v. (2 μs. dur.)
	40	2.5		40	13.		30	20.		" "	150 v. Trig. of 1 μs. dur. will not flip circuit.
	70	3.2		70	17.		50	15.			
	100	3.8		100	20.						
	200	6.2		200	27.						
	300	11.0		300	35.						
	400	18.		400	42.						
	500	26.		500	48.						
	600	36.		600	50.						
	700	43.		700	52.						
				800	53.						
				1 Mc. (72 v. plate swing)	52.						

OUTPUT	Nominal #1	Nominal #2	ΔE_F = −10 % #1	ΔE_F = −10 % #2	ΔE_F = −20 % #1	ΔE_F = −20 % #2	ΔE_{BB} = −10 % #1	ΔE_{BB} = −10 % #2	ΔE_{BB} = +10 % #1	ΔE_{BB} = +10 % #2
FLIP	45	142	45	142	46	142	43	128	48	156
FLOP	142	46	142	47	142	48	128	44	156	49
SWING	97	96	97	95	96	94	85	84	108	107

COMMENTS: For typical output coupling method see reverse side of data sheet.

DATA: (TUBE USED IN TEST)

	#1	#2
G_M	3230	3230

EMISSION WITH 12 K LOAD

E_{BB} = 150 v., E_C = 0 v.

ΔE_F	#1	#2
0	7.8 ma.	7.6 ma.
−10 %	7.5 "	7.3 "
−20 %	7.2 "	7.1 "

EMISSION AS ABOVE TAKEN FROM AVERAGE 6211 TUBE CHARACTERISTIC 7.8 MA.

CIRCUIT DATA: POWER REQUIREMENTS:

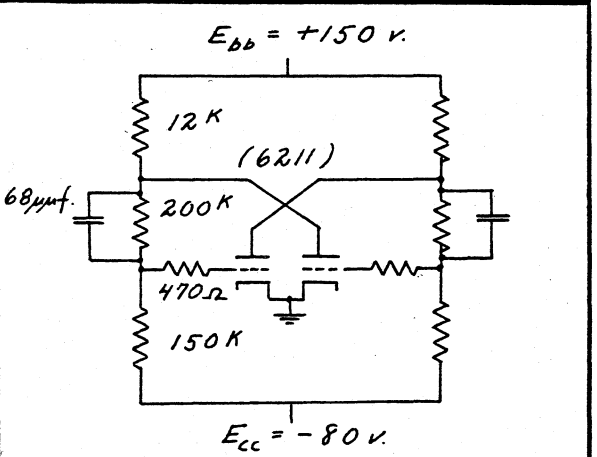
+150 v. Supply	9.2 ma.	
−80 v. "	1.0 "	
6.3 v. "	300. "	

GRID AND CATHODE LEVELS	#1	#2	K	#1	#2	K
TUBE INPLACE	+.4	−25	0			
	−26	+.4	0			
TUBE REMOVED	+14					
		+15				

OUTPUT: RISE TIME (NEG. GOING) .17 μs

DECAY TIME (POS. GOING) 2.3 μs

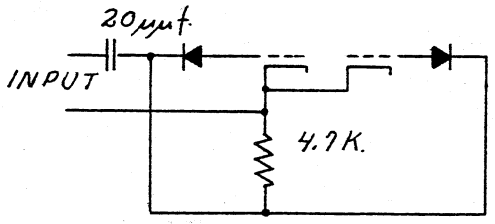
(100 Kc., 14 μμf. plate load, 10v. trigger)



Resistor tol. ±5%
Matched to ±2%

Daystrom Instrument Division

Daystrom Inc.



RISE TIME	MIN. TRIG.
.06 μs.	20 v.
.08	20
.13	20
.16	21
.18	21.5
.20	22
.22	22.8
.25	24.
.28	24.2
.29	24.5
.32	25.
.35	26.8
.41	28.

Coupling as shown at left.
200 Kc., 1 μs. Dur. Trigger
14 μμf. plate load.

INPUT	DIODE COUPLING FREQ.	MIN. TRIG.	DUR.	CAPACITIVE COUPLING 30 μμF FREQ.	MIN. TRIG.	DUR.
	20 Kc.	2.8 v.	3.0 v. 1 μs.	20 Kc.	14 v.	13. v. 1 μs.
	30	2.8	3.0	30	14	13.
	40	3.0	3.2	40	15	13
	70	3.0	3.2	70	15	13
	100	3.3	3.3	100	15	13
	200	4.0	4.4	200	15	13
	400	6.0	6.2	400	15	14
	500	7.2	7.6	500	16	14
	600	9.8	8.6	600	17	15
	800	16.	14.	800	19	17
	1. Mc	24.	22.	1 Mc.	19	18
	1.5		54.			

200 Kc. TRIGGER

C_C	MIN. TRIG.	DUR.
10 μμf.	26 v.	1 μs.
30	15	
50	76	

C_C = 30 μμF

PLATE LOAD	MIN. TRIG.
100K, 50μμf.	90 v. (1μs. dur.) 62 v. (2μs. dur.)
100K, 100μμf.	64 v. (2μs. dur.)

C.F. Load – Min. Trig. is independent of load.

OUTPUT	Nominal #1	Nominal #2	C.F. Output	ΔE_F = – 10 % #1	ΔE_F = – 10 % #2	ΔE_F = – 20 % #1	ΔE_F = – 20 % #2	ΔE_{BB} = – 10 % #1	ΔE_{BB} = – 10 % #2	ΔE_{BB} = + 10 % #1	ΔE_{BB} = + 10 % #2
FLIP	110	163	112	110	163	110	163	99	147	120	180
FLOP	163	109	163	163	110	163	110	148	99	180	120
SWING	53	54	51	53	53	53	53	49	48	60	60

COMMENTS: Min. Trig. given in first column is for 14 μμf - 10 Meg. plate load second column is for Cathode Follower load. For a test of Min. trigger amplitude vs. trigger Rise Time see reverse side of data sheet.

DATA: (TUBE USED IN TEST)

	#1	#2
G_M	2250	2300

EMISSION WITH 12 K LOAD

E_{BB} = 140 v.; E_C = 0 v.

ΔE_F	#1	#2
0	6.6 ma.	6.6 ma.
– 10 %	6.4 "	6.4 "
– 20 %	6.2 "	6.2 "

EMISSION AS ABOVE TAKEN FROM AVERAGE 5963 TUBE CHARACTERISTIC 6.6 MA.

CIRCUIT DAT.. : POWER REQUIREMENTS :

+200 v. Supply 11.0 ma.

6.3 v. " 300. "

GRID AND CATHODE LEVELS	#1	#2	K	#1	#2	K
TUBE IN PLACE	64	43	64			
	44	64	64			
TUBE REMOVED	64					
		64				

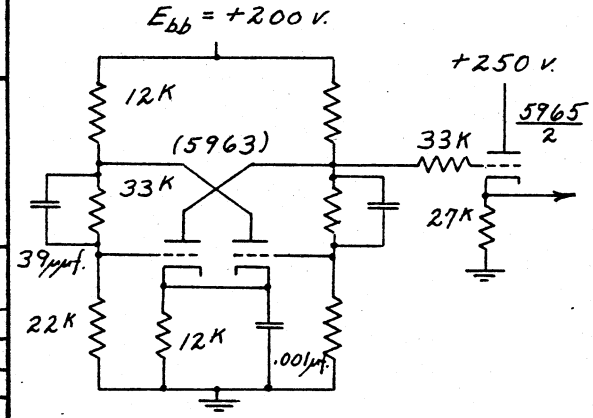
Plate OUTPUT: (200Kc., 14μμf plate load, 10 v. trigger)

RISE TIME (NEG. GOING) .20 μs

DECAY TIME (POS. GOING) 1.2 μs

C.F. Output: Rise Time .32 μs.

Decay Time 1.1 μs.



Resistor tol. ±1%

ElectroData Corporation

CAPACITIVE COUPLING $C_c = 10\ \mu\mu f.$		
Freq.	Min. Trig.	Dur.
20 Kc.	48 v.	3 μs.
40	63.	
80	88.	
100	94.	
200	130.	

INPUT	DIODE COUPLING			CAPACITIVE COUPLING 30 μμF			100 Kc. TRIGGER (.08 μs. Rise time)			C_c = 30 μμF
	FREQ.	MIN. TRIG.	DUR.	FREQ.	MIN. TRIG.	DUR.	C_c	MIN. TRIG.	DUR.	PLATE LOAD — MIN. TRIG.
	20 Kc.	12. v.	2.2 μs.	20 Kc.	33 v.	2.2 μs.	10 μμf.	94 v.	3 μs.	100K, 50 μμf. 47 v. (3 μs. dur.)
	60	20.		40	37.		30 μμf.	48 v.	3 μs.	100K, 100 μμf. 49 v. (3 μs. dur.)
	100	25.		80	46					(plate swing 59 v.)
	200	37.		100	49.					C_c = 10 μμf.
	400	53.		200	58					100K, 50 μμf. 104 v. (3 μs. dur.)
	600	56.	1.5 μs.	200	62	1.4				100K, 100 μμf. 114 v. (3 μs. dur.)
	800	60.		400	58					
	(plate swing 36 v.)			600	50					
				(53 v. plate swing)						
				800	46					
				(51 v. plate swing)						
				1 Mc.	48					
				(45 v. plate swing)						

OUTPUT	Nominal #1	Nominal #2	ΔE_F = −10 % #1	ΔE_F = −10 % #2	ΔE_F = −20 % #1	ΔE_F = −20 % #2	ΔE_{BB} = −10 % #1	ΔE_{BB} = −10 % #2	ΔE_{BB} = +10 % #1	ΔE_{BB} = +10 % #2
FLIP	97	191	98	191	98	191	88	173	107	210
FLOP	191	96	191	97	191	97	173	87	210	107
SWING	94	95	93	94	93	94	85	86	103	103

COMMENTS: For Capacitive coupling (C_c = 10 μμf.) see reverse side of data sheet.

DATA: (TUBE USED IN TEST)

	#1	#2
G_M	2260	2300

EMISSION WITH 33 K LOAD

E_{BB} = 130 v., E_C = 0 v.

ΔE_F	#1	#2
0	3 ma.	3 ma.
−10 %	2.9 "	2.9 "
−20 %	2.8 "	2.8 "

EMISSION AS ABOVE TAKEN FROM AVERAGE 5963 TUBE CHARACTERISTIC 3.0 MA.

CIRCUIT DATA: POWER REQUIREMENTS:

+200 v. Supply 3.5 ma.

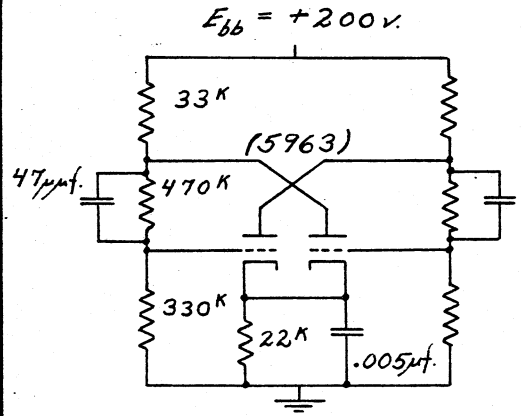
6.3 v. " 300. "

GRID AND CATHODE LEVELS	#1	#2	K	#1	#2	K
TUBE IN PLACE	68	38	68			
	39	68	68			
TUBE REMOVED	78					
		78				

OUTPUT: RISE TIME (NEG. GOING) 1.0 μs

DECAY TIME (POS. GOING) 3.6 μs

(100 Kc., 14 μμf. plate load, 50 v. trigger)

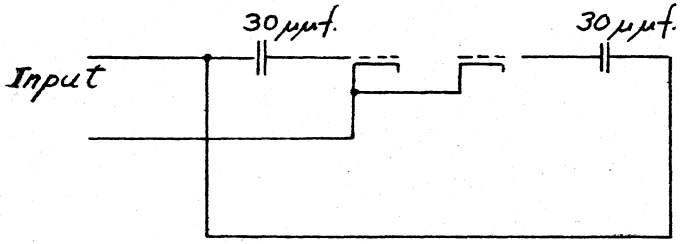


Similar to:

Z-8336, Z-8339, Z 8342, Z-90059, Z-91000

EECO. Production Company

BINARY TYPE COUPLING		
Freq.	Min. Trig.	Dur.
10 Kc.	14 V.	3 μs.
20	14	
40	16	
80	17	
100	17	
200	18	
300	21	
600	30	1.5 μs.



Binary type input coupling

INPUT

DIODE COUPLING

FREQ.	MIN. TRIG.	DUR.
10 Kc.	— v.	3 μs.
20	3.1	
40	3.7	
80	4.5	
100	5.0	
200	9.8	
400	15.	2 μs.
600	20.	1 μs.

(plate swing 40v.)

CAPACITIVE COUPLING 30 μμF

FREQ.	MIN. TRIG.	DUR.
20 Kc.	12.0 v.	3 μs.
40	13.5	
80	14.5	
100	15.	
200	16.	
200	16.	2 μs.
400	17.	
600	18.	

TRIGGER (.05 μs. Rise time)

100 Kc.

C_c	MIN. TRIG.	DUR.
10 μμf.	35. v.	3 μs.
30	15.	

C_c = 30 μμF

PLATE LOAD	MIN. TRIG.
100K, 50 μμf. (3 μs. dur.)	15 v.
100K, 100 μμf. (3 μs. dur.)	15.5 v.
100K, 185 μμf. (3 μs. dur.)	20. v.

(no change in output swing)
Output wave shape is unchanged by 24K load.

OUTPUT	Nominal #1	Nominal #2	Diodes Removed #1	Diodes Removed #2	ΔE_F = −10% #1	ΔE_F = −10% #2	ΔE_F = −20% #1	ΔE_F = −20% #2	ΔE_{BB} = −10% #1	ΔE_{BB} = −10% #2	ΔE_{BB} = +10% #1	ΔE_{BB} = +10% #2
FLIP	-40.5	+.5	-93	+77	-93	+77	-93	+77	-96	+68	-90	+87
FLOP	+.5	-40.5	+76	-91	+76	-91	+76	-91	+68	-94	+86	-86
SWING	41	41	169	168	169	168	169	168	164	162	176	173

COMMENTS: The output levels do not vary with ΔE_F = −20% and ΔE_{bb} = ± 10%. The output values listed above are for no plate clamping diodes in place. For binary type coupling see reverse side of data sheet.

DATA: (TUBE USED IN TEST)

	#1	#2
G_M	6600	6400

EMISSION WITH 39 K LOAD
E_{BB} = 210 v., E_C = 0 v.

ΔE_F	#1	#2
0	4.4 ma.	4.6 ma.
−10%	4.3 "	4.5 "
−20%	4.2 "	4.4 "

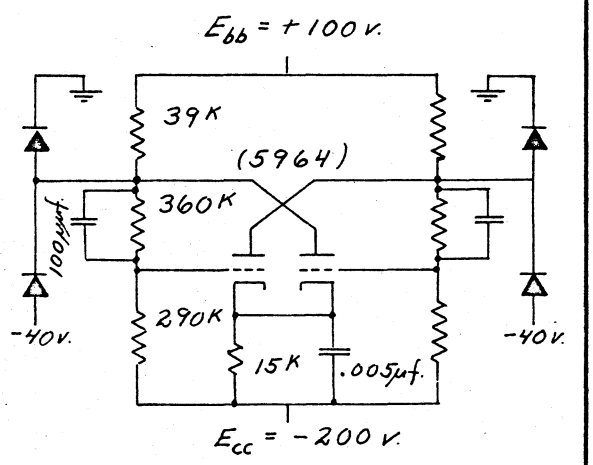
EMISSION AS ABOVE TAKEN FROM AVERAGE 5964 TUBE CHARACTERISTIC
4.2 MA.

CIRCUIT DATA: **POWER REQUIREMENTS:**

+100 v. Supply 6.0 ma.
−200 v. " 6.0 "
6.3 v. " 450. "

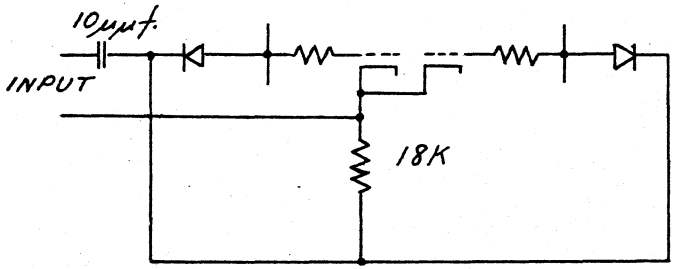
GRID AND CATHODE LEVELS	Nominal #1	Nominal #2	Nominal K	Diodes Removed #1	Diodes Removed #2	Diodes Removed K
TUBE IN PLACE	-108	-127	-108	-117	-139	-117
	-127	-108	-108	-147	-120	-120
TUBE REMOVED	-108			-73		
		-108			-72	

OUTPUT: RISE TIME (NEG. GOING) .8 μs
DECAY TIME (POS. GOING) .6 μs
(100 Kc., 14 μμf. plate load, 8.8 v. trigger)



Mfg. Type: Z-90052

EECO Production Company



Binary Type Coupling

BINARY TYPE COUPLING		
Freq.	Min. Trig.	Dur.
10 Kc.	12. V.	.8μs.
40	12.	
70	13.	
100	14.	.6μs.
200	14.	
400	16.	
600	17.	
800	22.	
1 Mc.	24.	.5μs.
1.5	39.	.4μs.
2	58.	.3μs.

INPUT	DIODE COUPLING FREQ.	MIN. TRIG.	DUR.	CAPACITIVE COUPLING 30 µµF FREQ.	MIN. TRIG.	DUR.	200 Kc. TRIGGER (.05 µs. Rise time) C_c	MIN. TRIG.	DUR.
	40 Kc.	2.6 V.	.8 µs.	20 Kc.	10. V.	.8 µs.	10 µµf.	15. V.	.7 µs.
	70	3.0		40	10.		30	10.4	.7 µs.
	100	3.3		70	10.		(At 1 Mc.)		
	200	4.6		100	11.		10 µµf.	23. V.	.7 µs.
	400	7.5		200	10.4		30	13.	.5 µs
	600	10.		400	11.		(At 2 Mc.)		
	800	14.		600	13.		10 µµf.	42. V.	.5 µs
	1 Mc.	17.		800	13.		30	18.	.4 µs
	1.5	30.	.5 µs.	1 Mc.	13.				
	2	50.		1.5	14.	.5 µs.			
	(72 v. plate swing)			2	18.	.4 µs.			

C_c = 30 µµF

PLATE LOAD	MIN. TRIG.
100 K, 50 µµf.	15. V.
100 K, 100 µµf.	50. V.

OUTPUT	Nominal #1	Nominal #2	ΔE_F = −10 % #1	ΔE_F = −10 % #2	ΔE_F = −20 % #1	ΔE_F = −20 % #2	ΔE_{BB} = −10 % #1	ΔE_{BB} = −10 % #2	ΔE_{BB} = +10 % #1	ΔE_{BB} = +10 % #2
FLIP	89	180	89	180	90	179	81	160	94	196
FLOP	179	93	179	93	179	94	160	84	195	99
SWING	90	87	90	87	89	85	79	76	101	97

COMMENTS: For Binary type coupling see reverse side of data sheet.

DATA: (TUBE USED IN TEST)

	#1	#2
G_M	6100	6700

EMISSION WITH 10 K LOAD

E_{BB} = 160 v., E_C = 0 v.

ΔE_F	#1	#2
0	9.9 ma.	10. ma.
−10 %	9.5 "	9.7 "
−20 %	9.1 "	9.2 "

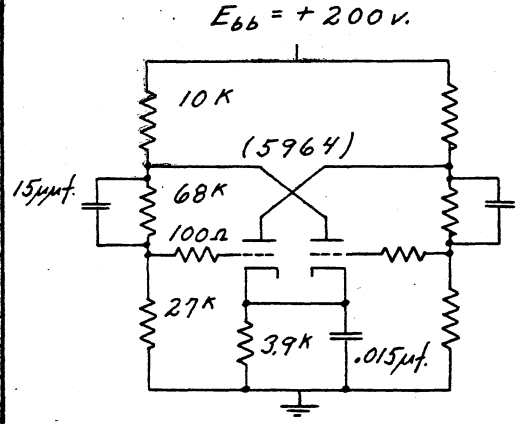
EMISSION AS ABOVE TAKEN FROM AVERAGE 5964 TUBE CHARACTERISTIC 8.7 MA.

CIRCUIT DATA: POWER REQUIREMENTS:

+200 v. Supply 12.4 ma.
6.3 v. " 450. "

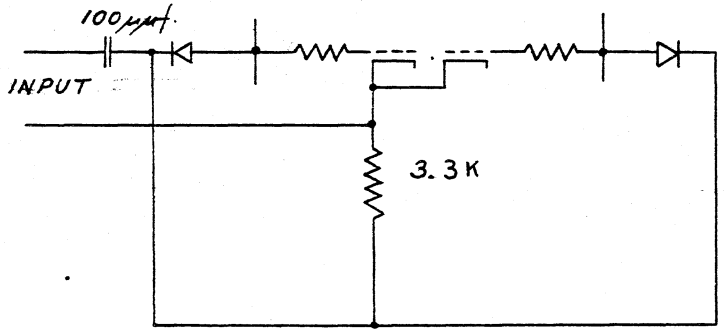
GRID AND CATHODE LEVELS	#1	#2	K	#1	#2	K
TUBE IN PLACE	39	26	39			
	25	39	39			
TUBE REMOVED	50					
		50				

OUTPUT: RISE TIME (NEG. GOING) .13 µs
DECAY TIME (POS. GOING) .8 µs
(200 Kc., 14 µµf. plate load, 10 v. trigger)



Mfg. Type: Z-90048

EECO Production Company



BINARY TYPE COUPLING				
Freq.		Min. Trig.		Dur.
10	Kc.	4.	V.	1.5 μs.
40		4.		
60		4.		
80		4.		
100		4.		
200		4.		
300		4.5		
400		4.5		
500		5.		
750		10.		
1	Mc.	15.		

INPUT	DIODE COUPLING FREQ.	MIN. TRIG.	DUR.	CAPACITIVE COUPLING 30 μμF FREQ.	MIN. TRIG.	DUR.	200Kc. TRIGGER (.05μs. Rise time) C_c	MIN. TRIG.	DUR.	C_c = 30 μμF PLATE LOAD	MIN. TRIG.
	20 Kc.	2.7 v.	1.5 μs.	20 Kc.	8.0 v.	1 μs.	10 μμf.	18. v.	1 μs.	100K, 50μμf.	16. v. (1μs. dur.)
	40	2.8		40	8.0		30	8.5		100K, 100μμf.	28v. (1μs. dur.)
	70	4.2		70	8.0					Load at Output #1	
	100	5.4		100	8.0					100K, 50μμf.	10v. (1μs. dur.)
	200	6.6	.8 μs.	200	8.5					100K, 100μμf.	10v. (1μs. dur.)
	400	11.0		400	10.0						
	600	15.		600	12.0						
	800	19.		800	14.						
	1 Mc.	21.		1 Mc.	16.						
				(Output #1 swing 22v.)							
				1.5	25.	.6 μs.					

OUTPUT	Nominal #1	Nominal #2	ΔE_F = −10 % #1	ΔE_F = −10 % #2	ΔE_F = −20 % #1	ΔE_F = −20 % #2	ΔE_{BB} = −10 % #1	ΔE_{BB} = −10 % #2	ΔE_{BB} = +10 % #1	ΔE_{BB} = +10 % #2
FLIP	+12	−43	+13	−42	+13	−41	+8	−45	+16	−41
FLOP	+36	+14	+36	+14	+36	+14	+31	+10	+40	+18
SWING	24	57	23	56	23	55	23	55	24	59

COMMENTS: Output #1 and #2 correspond to the points shown on the schematic. Min. Trig. Tests are conducted with 14μμf. load at Output #1. For Binary type coupling see reverse side of data sheet.

DATA: (TUBE USED IN TEST)

	#1	#2
G_M	4250	4200

EMISSION WITH 11.5 K LOAD

E_{BB} = 150 v., E_C = 0 v.

ΔE_F	#1	#2
0	6.8 ma.	6.7 ma.
−10 %	6.4 "	6.2 "
−20 %	5.8 "	5.6 "

EMISSION AS ABOVE TAKEN FROM AVERAGE 12AT7 TUBE CHARACTERISTIC

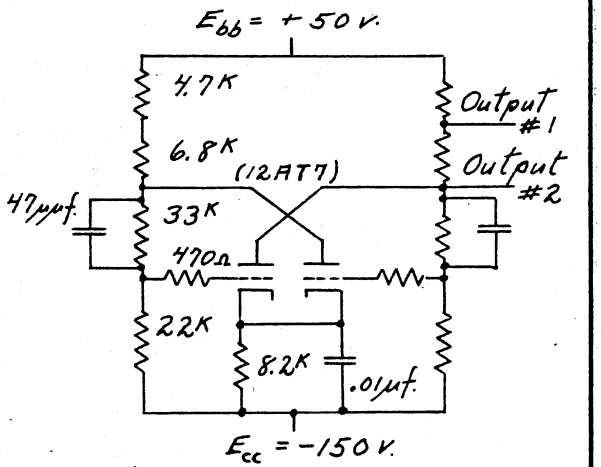
6.3 MA.

CIRCUIT DATA: POWER REQUIREMENTS:

+50 v. Supply 11.2 ma.
−150 v. " 11.2 "
6.3 v. " 300. "

GRID AND CATHODE LEVELS	#1	#2	K	#1	#2	K
TUBE IN PLACE	−94	−109	−95			
	−109	−94	−95			
TUBE REMOVED	−85					
		−86				

OUTPUT #1 RISE TIME (NEG. GOING) .18 μs
DECAY TIME (POS. GOING) 1.1 μs
(200Kc., 14μμf plate load, 20v. Trigger)



Resistor tol. ± 5%

Use: Counter

Elliott Brothers (London) Ltd.

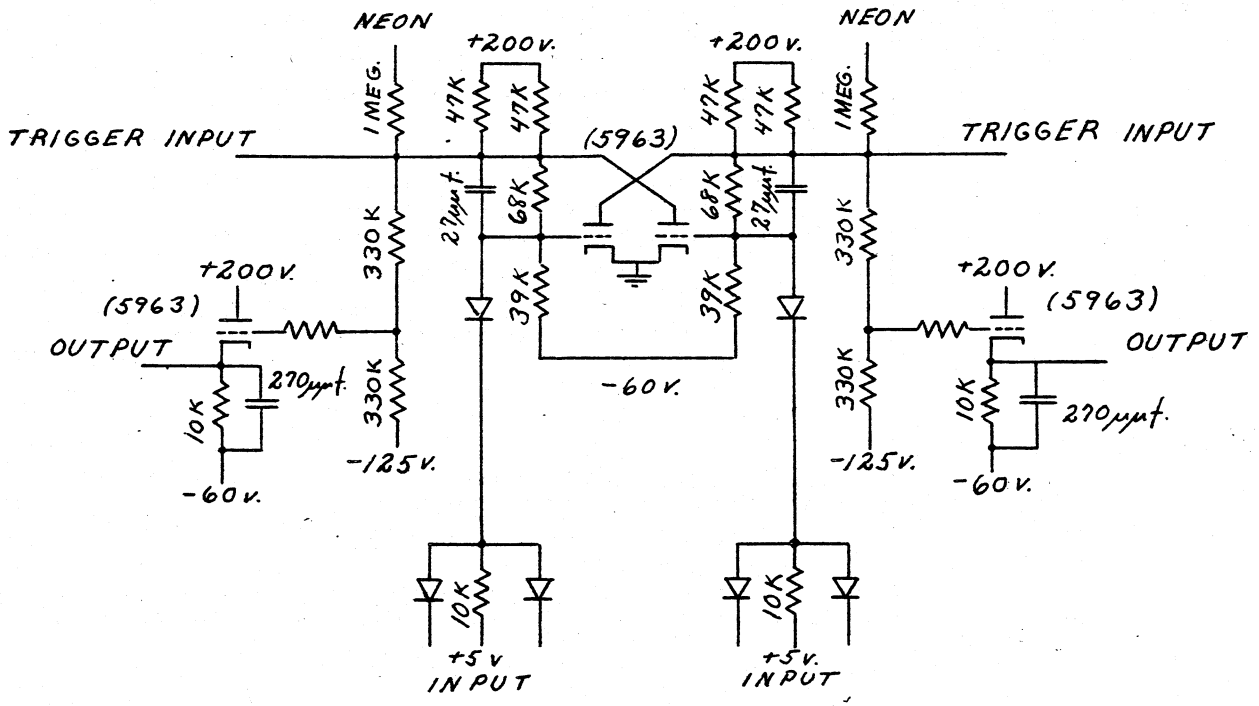


PLATE TRIGGERING C_c = 30μμf.		
Freq.	Min. Trig	Dur.
20 Kc.	42 v.	1 μs.
30	42	
40	42	
70	42	
100	42	
200	45	
400	70	
500	84	
600	88	
800	86	

(62 v. plate swing)

INPUT

DIODE COUPLING

FREQ.	MIN. TRIG.	DUR.
20 Kc.	3.4 V.	.5 μs.
30	3.4	
40	3.6	
70	3.8	
100	4.2	
200	5.6	
400	8.2	
600	16.	
800	41.	
1 Mc.	74.	

CAPACITIVE COUPLING 30 μμF

FREQ.	MIN. TRIG.	DUR.
20 Kc.	20. V.	1 μs.
30	20.	
40	20.	
70	20.	
100	21.	
200	21.	
400	24.	
600	27.	
800	30.	
1 Mc.	32. (88 v. plate swing)	
1.5	28. (62 v. plate swing)	

200 Kc. TRIGGER (.05 μs. Rise time)

C_C	MIN. TRIG.	DUR.
10 μμf.	40 V.	1 μs.
30	21	
50	19	

C_C = 30 μμF

PLATE LOAD	MIN. TRIG.
100K, 50μμf.	116 V. (1 μs. dur.)
	40 V. (2 μs. dur.)
	37 V. (3 μs. dur.)

OUTPUT

	Nominal #1	Nominal #2	ΔE_F = −10 % #1	ΔE_F = −10 % #2	ΔE_F = −20 % #1	ΔE_F = −20 % #2	ΔE_{BB} = −10 % #1	ΔE_{BB} = −10 % #2	ΔE_{BB} = +10 % #1	ΔE_{BB} = +10 % #2
FLIP	35	149	36	149	36	149	36	134	35	163
FLOP	149	35	149	35	149	35	134	35	163	35
SWING	114	114	113	114	113	114	98	99	128	

COMMENTS: For plate triggering and the complete circuit as submitted by the Mfg. see reverse side of data sheet.

DATA: (TUBE USED IN TEST)

	#1	#2
G_M	2250	2300

EMISSION WITH 23.5 K LOAD

E_{BB} = 200 v., E_C = 0 v.

ΔE_F	#1	#2
0	6.2 ma.	6.2 ma.
−10 %	6.0 "	6.0 "
−20 %	5.9 "	5.9 "

EMISSION AS ABOVE TAKEN FROM AVERAGE 5963 TUBE CHARACTERISTIC

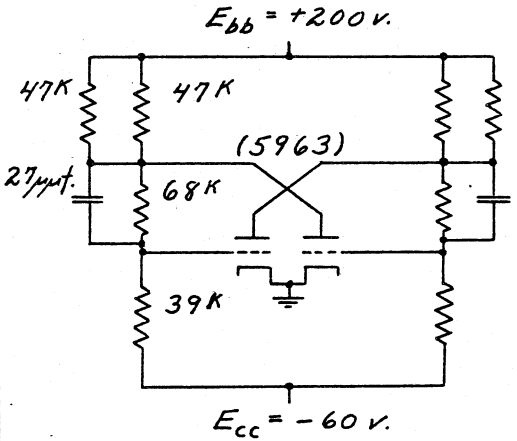
6.0 MA.

CIRCUIT DATA: POWER REQUIREMENTS:

+200 v. Supply 9.4 ma.
−60 v. " 2.4 "
6.3 v. " 300. "

GRID AND CATHODE LEVELS	#1	#2	K	#1	#2	K
TUBE IN PLACE	+1.1	−25	0			
	−25	+1.1	0			
TUBE REMOVED	+17					
		+17				

OUTPUT: RISE TIME (NEG. GOING) .27 μs
DECAY TIME (POS. GOING) 2.0 μs
(200 Kc., 14 μμf. plate load, 10 v. Trigger)



Resistor tol. ±5%

Used in: "ORDVAC"

Engineering Research Associates

INPUT	DIODE COUPLING FREQ.	MIN. TRIG.	DUR.	PULLER TUBE COUPLING FREQ.	MIN. TRIG.	DUR.	200 Kc. TRIGGER (.05 μs. Rise Time) C_c	MIN. TRIG.	DUR.	PULLER TUBE COUPLING PLATE LOAD	MIN. TRIG.
	20 Kc.	3. v.	.4 μs.	20 Kc.	11. V.	.5 μs.	See Comments			100K, 50 μμf	15 V. (.9 μs. dur.)
	100	2.8		100	12.						
	200	6.4		200	12.					Ckt. is inoperative for a plate load < 39K	
	400	15.		400	13.						
	800	40.		600	15.						
				800	17.						
				1 Mc.	18.						
				(plate waveform deteriorates with Trig. < 30 v.)							

OUTPUT	Nominal #1	Nominal #2	ΔE_F = −10 % #1	ΔE_F = −10 % #2	ΔE_F = −20 % #1	ΔE_F = −20 % #2	ΔE_{BB} = −10 % #1	ΔE_{BB} = −10 % #2	ΔE_{BB} = +10 % #1	ΔE_{BB} = +10 % #2
FLIP	27	103	28	103	29	103	26	92	28.5	112
FLOP	103	27	103	27.5	103	28	92	25.5	112	28
SWING	76	76	75	75.5	74	75	66	66.5	83.5	84

COMMENTS: Will not trigger satisfactoraly with capacitive coupling due to absence of "speed-up capacitors". For example: at 200Kc., C_c = 30 μμf., Min. Trig. = 90 v.

DATA: (TUBE USED IN TEST)

	#1	#2
G_M	4300	5600

EMISSION WITH 15 K LOAD

E_{BB} = 150 v., E_C = 0 v.

ΔE_F	#1	#2
0	6. ma.	6.3 ma.
−10 %	5.7 "	6.0 "
−20 %	5.4 "	5.7 "

EMISSION AS ABOVE TAKEN FROM AVERAGE 6J6 TUBE CHARACTERISTIC 6.3 MA.

CIRCUIT DATA: POWER REQUIREMENTS:

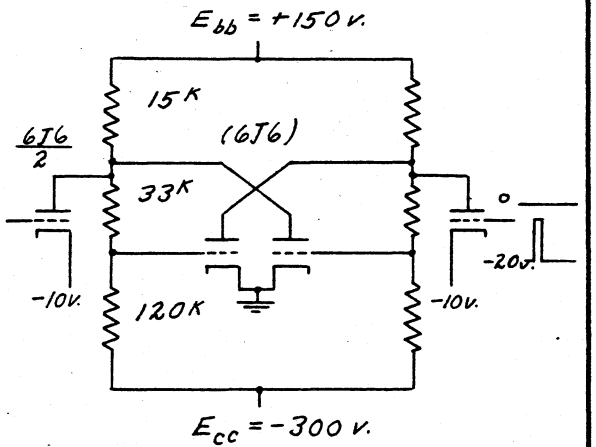
+150 v.	Supply	11.0 ma.
−300 v.	"	4.4 "
6.3 v.	"	450. "

GRID AND CATHODE LEVELS	#1	#2	K	#1	#2	K
TUBE IN PLACE	.6	−41	0			
	−41	.7	0			
TUBE REMOVED	27					
		27				

OUTPUT: RISE TIME (NEG. GOING) .25 μs

DECAY TIME (POS. GOING) .8 μs

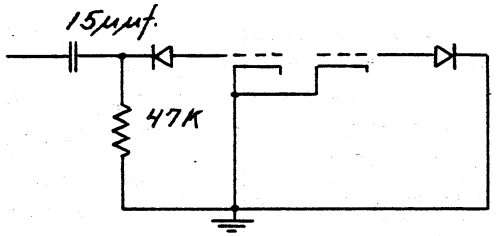
(200 Kc., 14 μμf plate load)



Resistor tol. ±3%

Used in: "ILLIAC", "ORDVAC"

Univ. of Illinois



BINARY TYPE COUPLING		
Freq.	Min. Trig.	Dur.
10 Kc.	13. v.	1 μS.
40	13.	
70	13.	
100	14.	
200	14.	
300	15.	
400	17.	
500	19.	
600	20.	
700	21.	
800	23.	
900	24.	
1 Mc.	25.	
1.2	33.	

INPUT	DIODE COUPLING			CAPACITIVE COUPLING 30 μμF			200 Kc. TRIGGER			C_c = 30 μμF
	FREQ.	MIN. TRIG.	DUR.	FREQ.	MIN. TRIG.	DUR.	C_c	MIN. TRIG.	DUR.	PLATE LOAD MIN. TRIG.
	20 Kc.	2.0 v.	1 μs.	20 Kc.	10. v.	1 μs.	10 μμf.	22. v.	1 μs.	100K, 50 μμf. 28 v. (1 μs. dur.)
	30	2.0		30	10.		30	10.		100K, 100 μμf. 30 v. (1 μs. dur.)
	40	2.5		40	10.		50	22.		Load at output #2
	70	3.0		70	10.					100K, 50 μμf. 11 v. (1 μs. dur.)
	100	3.4		100	10.					100K, 100 μμf. 12 v. (1 μs. dur.)
	200	5.2		200	10.					(12 v. swing at Output #2)
	400	8.8		400	10.8					
	600	14.		600	11.					
	800	15.		800	11.4					
	1 Mc.	22.		1. Mc.	11.6					
	1.5	22.	.6 μs.	1.5	14.					
	2	50.								

OUTPUT	Diodes Removed #1	Diodes Removed #2	Nominal #1	Nominal #2	ΔE_F = −10 % #1	ΔE_F = −10 % #2	ΔE_F = −20 % #1	ΔE_F = −20 % #2	ΔE_{BB} = −10 % #1	ΔE_{BB} = −10 % #2	ΔE_{BB} = +10 % #1	ΔE_{BB} = +10 % #2
FLIP	50	−42	50	−41	51	−40	52	−39	52	−40	53	−40
FLOP	129	+10	129	+10	129	+10	129	+10	114	+.7	141	+18
SWING	79	52	79	51	78	50	77	49	62	40.7	88	58

COMMENTS: Output #1 and #2 refer to the points marked on the schematic and not to each plate. Min. Trig. Tests conducted with 14 μμf. load at output #2. For Binary type coupling see reverse side of data sheet.

DATA: (TUBE USED IN TEST)

	#1	#2
G_M	6600	6300

EMISSION WITH 10 K LOAD

E_{BB} = 150 v., E_C = 0 v.

ΔE_F	#1	#2
0	8.8 ma.	8.6 ma.
−10 %	8.4 "	8.2 "
−20 %	7.8 "	7.6 "

EMISSION AS ABOVE TAKEN FROM AVERAGE 5965 TUBE CHARACTERISTIC 9.2 MA.

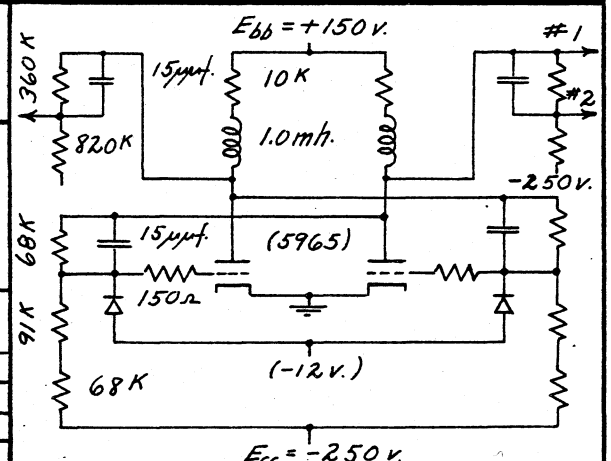
CIRCUIT DATA: POWER REQUIREMENTS:

+150 v. Supply 12.4 ma.
−250 v. " 3.5 "
6.3 v. " 450. "

GRID AND CATHODE LEVELS	Nominal #1	Nominal #2	Nominal K	Diodes Removed #1	Diodes Removed #2	Diodes Removed K
TUBE IN PLACE	+.2	−12	0	+.2	−39	0
	−12	+.2	0	−40	+.2	0
TUBE REMOVED	+15			+15.5		
		+15.5			+16	

(200 Kc., 14 μμf. load, 10 v. trigger)

OUTPUT #1 RISE TIME (NEG. GOING)	.13	μs
DECAY TIME (POS. GOING)	.48	μs
Output #2 Rise Time	.14	μs
Decay Time	.5	μs.



Flip-Flop Resistor Tol. ± 5%
Divider " " ± 2.5 %

Used in: "701" Computor

International Business Machines

INPUT	DIODE COUPLING			CAPACITIVE COUPLING 30 µµF			200 Kc. TRIGGER			C_c = 30 µµF
	FREQ.	MIN. TRIG.	DUR.	FREQ.	MIN. TRIG.	DUR.	C_c	MIN. TRIG.	DUR.	PLATE LOAD MIN. TRIG.
	20 Kc.	2.4 v.	1 µs.	20 Kc.	11. v.	1 µs.				100K, 50µµf. 106 v. (1 µs. dur.)
	30	2.7		30	12.		10 µµf.	60 v.	1 µs.	
	40	2.8		40	14.		25	28		Load at Output #1
	70	3.8		70	17.		30	25		
	100	4.4		100	19.		50	17		100K, 50µµf. 28 v. (1 µs. dur.)
	200	7.0		200	25.					
	300	11.		300	32.					100K, 90µµf. 50 v. (1 µs. dur.)
	400	18.		400	38.					
	500	22.		500	40.					
	600	30.		600	44.					
	700	38.		700	46.					
				1 Mc.	50.					
				(Output #1 swing 44v.)						

OUTPUT	Nominal		ΔE_F = − 10 %		ΔE_F = − 20 %		ΔE_{BB} = − 10 %		ΔE_{BB} = + 10 %	
	#1	#2	#1	#2	#1	#2	#1	#2	#1	#2
FLIP	86	50	86	50	87	51	78	46	93	53
FLOP	136	132	136	132	136	132	121	118	149	145
SWING	50	82	50	82	49	81	43	72	56	92

COMMENTS: Output #1 and #2 refer to the points shown on the schematic and not to each plate.
For puller tube triggering, the speed-up capacitor = 15µµf.
Min. Trig. tests made with 14µµf. load at Output #1

DATA: (TUBE USED IN TEST)

	#1	#2
G_M	3230	3230

EMISSION WITH 9.2 K LOAD
E_{BB} = 140 v., E_C = 0 v.

ΔE_F	#1	#2
0	8.8 ma.	8.7 ma.
− 10 %	8.5 "	8.4 "
− 20 %	8.1 "	8.0 "

EMISSION AS ABOVE TAKEN FROM AVERAGE 6211 TUBE CHARACTERISTIC 8.6 MA.

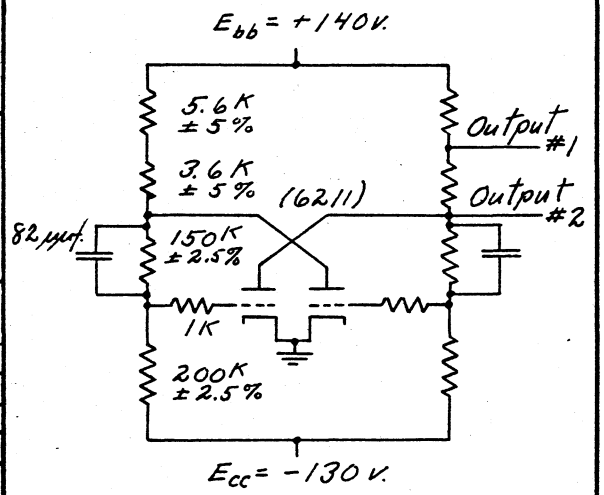
CIRCUIT DATA: POWER REQUIREMENTS:

+140 v.	Supply	10.7 ma.
−130 v.	"	1.2 "
6.3 v.	"	300. "

GRID AND CATHODE LEVELS	#1	#2	K	#1	#2	K
TUBE IN PLACE	+.6	−26	0			
	−25.5	+.6				
TUBE REMOVED	+21					
		+20				

(200Kc., 14µµf. load, 15v. Trigger)

OUTPUT #1 RISE TIME (NEG. GOING)	.2	µs
DECAY TIME (POS. GOING)	1.4	µs
Output #2 Rise Time	.2	µs
Decay Time	1.5	µs



International Business Machines
San Jose, Calif.

INPUT	DIODE COUPLING FREQ.	MIN. TRIG.	DUR.	CAPACITIVE COUPLING 30 UUF FREQ.	MIN. TRIG.	DUR.	200Kc. TRIGGER (.05 μs. Rise Time) C_c	MIN. TRIG.	DUR.
	20 Kc.	2.5 v.	1 μs.	20 Kc.	12. v.	1 μs.	10 μμf.	29. v.	1 μs.
	30	2.5		30	12.		30	15.	
	40	2.6		40	12.		50	11.2	
	70	3.2		70	13.				
	100	4.0		100	13.				
	200	6.2		200	15.				
	300	9.4		300	17.				
	400	15.		400	19.				
	500	20.		500	21.				
	600	26.		600	22.				
	800	40.		800	25.				
	1 Mc.	55.		1 Mc.	24.				
	(54v. plate swing)			1.5					

C_c = 30 UUF

PLATE LOAD MIN. TRIG.

100K, 50 μμf. 24 v. (1 μs. dur.)

100K, 100 μμf. 82 v. (1 μs. dur.)

" " 38 v. (2 μs. dur.)

OUTPUT	Nominal #1	Nominal #2	ΔE_F = −10 % #1	ΔE_F = −10 % #2	ΔE_F = −20 % #1	ΔE_F = −20 % #2	ΔE_{BB} = −10 % #1	ΔE_{BB} = −10 % #2	ΔE_{BB} = +10 % #1	ΔE_{BB} = +10 % #2
FLIP	18	79	18	79	18.5	79	18	70	18.5	86
FLOP	79	18.5	79	19	79	19	70	18	86	19
SWING	61	60.5	61	60	60.5	60	52	52	67.5	67

COMMENTS:

DATA: (TUBE USED IN TEST)

	#1	#2
G_M	2250	2300

EMISSION WITH 18 K LOAD

E_{BB} = 120 v., E_C = 0 v.

ΔE_F	#1	#2
0	4.3 ma.	4.4 ma.
−10 %	4.2 "	4.3 "
−20 %	4.1 "	4.1 "

EMISSION AS ABOVE TAKEN FROM AVERAGE 5963 TUBE CHARACTERISTIC

4.3 MA.

CIRCUIT DATA: POWER REQUIREMENTS:

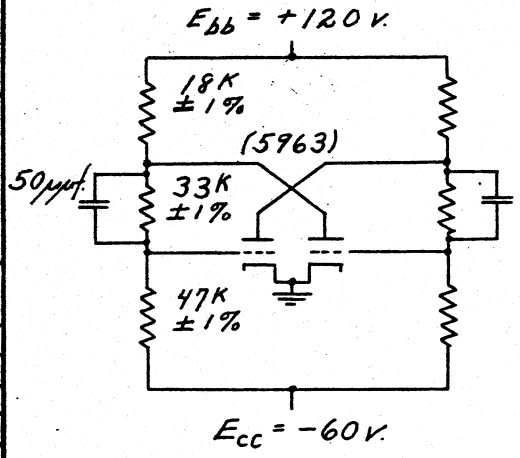
+120 v. Supply 8.5 ma.
−60 v. " 2.4 "
6.3 v. " 300. "

GRID AND CATHODE LEVELS	#1	#2	K	#1	#2	K
TUBE IN PLACE	+1.5	−14	0			
	−14.5	+1.5	0			
TUBE REMOVED	+25					
		+25.5				

OUTPUT: RISE TIME (NEG. GOING) .2 μs

DECAY TIME (POS. GOING) 1.9 μs

(200 Kc., 14 μμf. plate load, 10 v. Trigger)



Marchant Research Inc.

CAPACITIVE COUPLING $C_c = 50\ \mu\mu f.$		
Freq.	Min. Trig.	Dur.
10 Kc.	12. V.	7 μs.
15	15.	
20.	19.	
30	27.	
40	35.	
60	48.	
80	54.	
100	64.	
150	68.	

INPUT	DIODE COUPLING FREQ.	MIN. TRIG.	DUR.	CAPACITIVE COUPLING 30 μμF FREQ.	MIN. TRIG.	DUR.	20 Kc. TRIGGER (.05-.1 μs. Rise Time) C_c	MIN. TRIG.	DUR.	C_c = 50 μμF PLATE LOAD	MIN. TRIG.
	10 Kc.	3.0 v.	7 μs.	10 Kc.	17. v.	7 μs.	10 μμf.	56 v.	7 μs.	100K, 50 μμf.	19 v. (7 μs. dur.)
	15	3.0		15	20.		30	36		100K, 100 μμf.	24 v. (7 μs. dur.)
	20	3.5		20	30.		50	19		100K, 185 μμf.	44 v. (7 μs. dur.)
	30	4.0		30	36.						
	40	4.8		40	45.						
	60	7.4		60	68.						
	80	11.0		80	80.						
	100	14.		100	92.						
	150	36.									

OUTPUT	Nominal #1	Nominal #2	ΔE_F = −10 % #1	ΔE_F = −10 % #2	ΔE_F = −20 % #1	ΔE_F = −20 % #2	ΔE_{BB} = −10 % #1	ΔE_{BB} = −10 % #2	ΔE_{BB} = +10 % #1	ΔE_{BB} = +10 % #2
FLIP	+88	−15	+88	−14	+88	−14	+77	−19	+98	−10
FLOP	−15	+88	−15	+88	−14	+88	−20	+77	−10	+98
SWING	103	103	103	102	102	102	97	96	108	108

COMMENTS: For capacitive coupling, C_c = 50 μμf. see reverse side of data sheet.

DATA: (TUBE USED IN TEST)

	#1	#2
G_M	3080	3150

EMISSION WITH 47 K LOAD

E_{BB} = 140 v., E_C = 0 v.

ΔE_F	#1	#2
0	2.5 ma.	2.5 ma.
−10 %	2.5"	2.5"
−20 %	2.4"	2.4"

EMISSION AS ABOVE TAKEN FROM AVERAGE 12AU7 TUBE CHARACTERISTIC

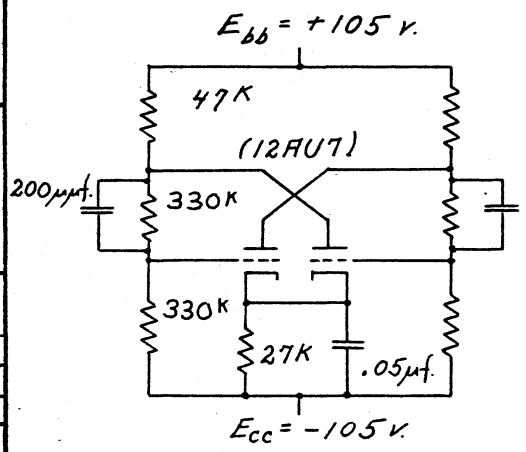
2.3 MA.

CIRCUIT DATA: POWER REQUIREMENTS:

+105 v. Supply 3.0 ma.
−105 v. " 3.0 "
6.3 v. " 300. "

GRID AND CATHODE LEVELS	#1	#2	K	#1	#2	K
TUBE IN PLACE	-35	-59	-35			
	-59	-35	-35			
TUBE REMOVED	-7					
		-7				

OUTPUT: RISE TIME (NEG. GOING) .5 μs
DECAY TIME (POS. GOING) 17. μs
(20 Kc., 14 μμf. plate load, 10 v. Trigger)



Resistor tol. ± 10%

Metrotype Corporation

INPUT	DIODE COUPLING FREQ.	MIN. TRIG.	DUR.	CAPACITIVE COUPLING ____ UUF FREQ.	MIN. TRIG.	DUR.	200 Kc. TRIGGER Diode Coupling C_C MIN. TRIG.	DUR.	PLATE LOAD	MIN. TRIG.
	20 Kc.	4.4 V.	1 μs.	Will not operate satisfactorily with cap. coupling due to the small ("speed-up capacitors" (10μμf.)					100 K, 50μμf.	33 v. (2 μs. dur.)
	30	4.8							Load at output #2	
	40	6.							100 K, 50μμf.	15 v. (1 μs. dur.)
	70	7.							100 K, 100μμf.	22. v. (1 μs. dur.)
	100	9.								
	200	13.								
	400	22.								
	500	28.								
	600	33.								
	800	46,								
	1 Mc.	64.								

OUTPUT	Diodes Removed #1	#2	Nominal #1	#2	$\Delta E_F = -10\%$ #1	#2	$\Delta E_F = -20\%$ #1	#2	$\Delta E_{BB} = -10\%$ #1	#2	$\Delta E_{BB} = +10\%$ #1	#2
FLIP	41	-69	43	-67	45	-63	51	-61	42	-67	47	-66
FLOP	191	+12	191	+12	191	+12.5	191	+12.5	173	+3	211	+22
SWING	150	81	148	79	146	75.5	140	73.5	131	70	164	88

COMMENTS: Output #1 and #2 refer to the points shown on the schematic. Min. Trig. tests made with 14μμf. load on Output #2

DATA: (TUBE USED IN TEST)

	#1	#2
G_M	6600	6300

EMISSION WITH 21.5 K LOAD

E_{BB} = 250 v., E_C = 0 v.

ΔE_F	#1	#2
0	8.4 ma.	8.2 ma.
-10%	8.0 "	7.8 "
-20%	7.6 "	7.5 "

EMISSION AS ABOVE TAKEN FROM AVERAGE 5965 TUBE CHARACTERISTIC

9.0 MA.

CIRCUIT DATA: POWER REQUIREMENTS:

+250 v.	Supply	11.6 ma.
-150 v.	"	2.2 "
-200 v.	"	1.0 "
6.3 v.	"	450. "

GRID AND CATHODE LEVELS	Nominal #1	#2	K	Diodes Removed #1	#2	K
TUBE IN PLACE	+.2	-46	0	+.2	-50	0
	-47	+.2	0	-50	+.2	0
TUBE REMOVED	0			+31		
		0			+30	

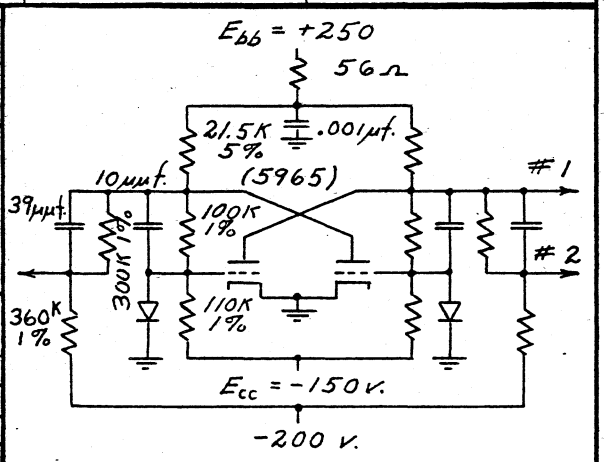
(200 Kc., 14μμf. load, 15 v. Trigger)

OUTPUT #1 RISE TIME (NEG. GOING) .8 μs

DECAY TIME (POS. GOING) 1.9 μs

Output #2 Rise Time .7 μs.

Decay Time 1.4 μs.



Used in "ENIAC"

Moore School of Electrical Engineering

INPUT

DIODE COUPLING

FREQ.	MIN. TRIG.	DUR.
20 Kc.	2.8 v.	1.2 μs.
40	3.8	.8
70	4.2	
100	4.6	
200	6.6	.6
400	10.8	
600	16.	.5
800	20.	
1 Mc.	25.	
2	38.	.4

(24 v. plate swing)

CAPACITIVE COUPLING 30 μμf

FREQ.	MIN. TRIG.		DUR.
	Min.	Max.	1 μs.
20 Kc.	17. v.	32. v.	
40	20.	33.	
70	20.	34.	.8
100	19.	36.	.7
200	20.	36.	.6
400	19.	44.	
600	18.	44.	
800	17.	76.	
1 Mc.	17.		.5
2	14.		

(20 v. plate swing)

200 Kc. TRIGGER (.05 μs. Rise Time)

C_c	MIN. TRIG.	DUR.
30 μμf.	20 v.	.6 μs.
10	42	.8

C_c = 30 μμf

PLATE LOAD	MIN. TRIG.
100 K, 50 μμf.	54 v. (.9 μs. dur.)
100 K, 100 μμf.	56 (.9 μs. dur.)

OUTPUT	Nominal #1	Nominal #2	ΔE_F = −10 % #1	ΔE_F = −10 % #2	ΔE_F = −20 % #1	ΔE_F = −20 % #2	ΔE_{BB} = −10 % #1	ΔE_{BB} = −10 % #2	ΔE_{BB} = +10 % #1	ΔE_{BB} = +10 % #2
FLIP	−18	+17	−18	+17	−18	+17	−18.5	+13	−17.5	+20
FLOP	+18	−17	+17	−17	+17.5	−17	+14.	−17.5	+20.5	−16.5
SWING	36	34	35	34	35.5	34	32.5	30.5	38	36.5

COMMENTS: Max. Trig. given in Capacitive Coupling column indicates voltage at which circuit will flip twice per trigger pulse.

DATA: (TUBE USED IN TEST)

	#1	#2
G_M	6100	6700

EMISSION WITH 18 K LOAD

E_{BB} = 110 v., E_C = 0 v.

ΔE_F	#1	#2
0	4.5 ma.	4.3 ma.
−10 %	4.4 "	4.2 "
−20 %	4.2 "	4.0 "

EMISSION AS ABOVE TAKEN FROM AVERAGE 5964 TUBE CHARACTERISTIC 3.8 MA.

CIRCUIT DATA: POWER REQUIREMENTS:

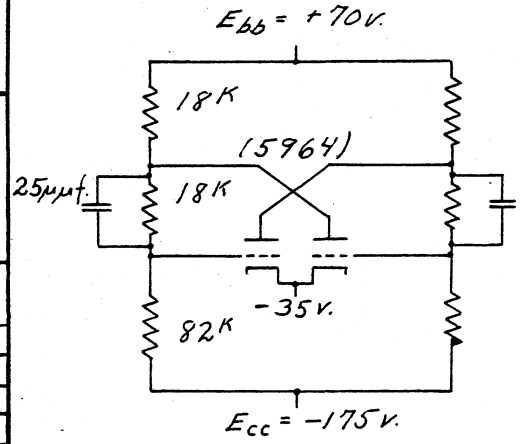
+70 v.	Supply	7.5 ma.
−175 v.	"	3.4 "
−35 v.	"	4.5 "
6.3 v.	"	450. "

GRID AND CATHODE LEVELS	#1	#2	K	#1	#2	K
TUBE IN PLACE	−35	−45	−35			
	−46	−35	−35			
TUBE REMOVED	−5					
		−5				

(200 Kc., 14 μμf. plate load, 10 v. Trigger)

OUTPUT: RISE TIME (NEG. GOING) .24 μs

DECAY TIME (POS. GOING) 1.0 μs



Resistor tol. ± 2%

Used in "EDVAC"

Moore School of Electrical Engineering

INPUT	DIODE COUPLING			CAPACITIVE COUPLING 30 μμF			200 Kc. TRIGGER (.05-.08 μs. Rise Time)			PLATE LOAD	MIN. TRIG.
	FREQ.	MIN. TRIG.	DUR.	FREQ.	MIN. TRIG.	DUR.	C_G	MIN. TRIG.	DUR.	C_c = 30 μμF	
	20 Kc.	1.3 v.	1 μs.	20 Kc.	2.5 v.	1 μs.	10 μμf.	5.0 v.	1 μs.	100K, 50 μμf.	3.5 v. (1 μs. dur.)
	40	1.4		40	2.5		30	2.5		100K, 100 μμf.	4.0 v. (1 μs. dur.)
	70	1.5		70	2.5						
	100	1.8		100	2.5						
	200	2.5		200	2.5						
	400	4.5		400	2.8						
	600	6.0		600	3.0						
	800	7.6		800	3.5						
	1 Mc.	9.4		1 Mc.	4.5						
	1.5	10.	.5 μs								
	(108 v. plate swing)										

OUTPUT	Nominal		ΔE_F = -10 %		ΔE_F = -20 %		ΔE_{BB} = -10 %		ΔE_{BB} = +10 %	
	#1	#2	#1	#2	#1	#2	#1	#2	#1	#2
FLIP	87	206	88	206	93	206	82	183	91	225
FLOP	206	89	206	92	206	97	183	86	224	95
SWING	119	117	118	114	113	109	101	97	133	130

COMMENTS:

DATA: (TUBE USED IN TEST)

	#1	#2
G_M	4250	4200

EMISSION WITH 12 K LOAD

E_{BB} = 225 v., E_C = 0 v.

ΔE_F	#1	#2
0	10.5 ma.	10.4 ma.
-10 %	10.0 "	9.8 "
-20 %	9.4 "	8.8 "

EMISSION AS ABOVE TAKEN FROM AVERAGE 12AT7 TUBE CHARACTERISTIC

9.8 MA.

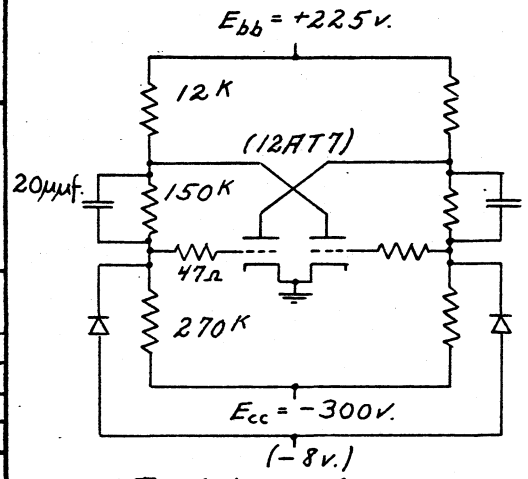
CIRCUIT DATA: POWER REQUIREMENTS:

+225 v. Supply 12.8 ma.
-300 v. " 2.2 "
6.3 v. " 300. "

GRID AND CATHODE LEVELS	#1	#2	K	Diodes Removed #1	#2	K
TUBE IN PLACE	+.1	-8	0	+.1	-47	0
	-8	+.1	0	-49	+.1	0
TUBE REMOVED	+27			+28		
		+28			+30	

OUTPUT: RISE TIME (NEG. GOING) .18 μs
DECAY TIME (POS. GOING) 1.2 μs

(200 Kc., 14 μμf. plate load, 5 v. Trigger)



Resistor tol. ±5%

National Cash Register Co.

INPUT	DIODE COUPLING FREQ.	MIN. TRIG.	DUR.	CAPACITIVE COUPLING 50 µµF FREQ.	MIN. TRIG.	DUR.	2 Kc. TRIGGER, Binary Type Input C_c	MIN. TRIG.	DUR.	C_c = 50 µµF PLATE LOAD	MIN. TRIG.
	10 Kc.	4.5 V.	7 µs.	Binary Type Coupling			10 µµf.	84. V.	7 µs.	100K, 50 µµf.	ckt. will not flip with a 100v. Trig.
	15	5.6		1.2 Kc.	25. V.	7 µs.	30	35.			
	20	5.8		1.5	25.		50	27.			
	30	6.8		1.8	26.		75	130.			
	40	8.4		2.	27.						
	60	14.		2.5	31.						
	80	17.		3.0	35.						
	100	22.									

OUTPUT	Nominal #1	Nominal #2	ΔE_F = −10 % #1	ΔE_F = −10 % #2	ΔE_F = −20 % #1	ΔE_F = −20 % #2	ΔE_{BB} = −10 % #1	ΔE_{BB} = −10 % #2	ΔE_{BB} = +10 % #1	ΔE_{BB} = +10 % #2
FLIP	14.5	136	14.5	136	15	136	14.5	121	15	149
FLOP	136.	15	136	15.5	136	16	121	15	149	16
SWING	121.5	121	121.5	120.5	121	120	106.5	106	134	133

COMMENTS:

DATA: (TUBE USED IN TEST)

	#1	#2
G_M	3080	3150

EMISSION WITH 100 K LOAD

E_{BB} = 150 v., E_C = 0 v.

ΔE_F	#1	#2
0	1.3 ma.	1.3 ma.
−10 %	1.3 "	1.3 "
−20 %	1.3 "	1.3 "

EMISSION AS ABOVE TAKEN FROM AVERAGE 12AU7 TUBE CHARACTERISTIC

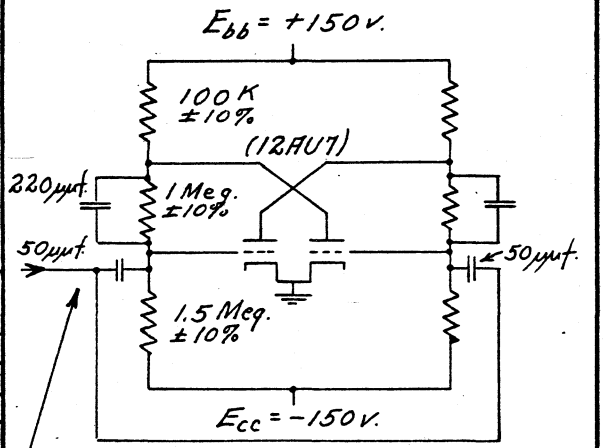
1.3 MA.

CIRCUIT DATA: POWER REQUIREMENTS:

+150 v. Supply 1.5 ma.
−150 v. " .2 "
6.3 v. " 300. "

GRID AND CATHODE LEVELS	#1	#2	K	#1	#2	K
TUBE IN PLACE	0	−48	0			
	−48	0	0			
TUBE REMOVED	+23					
		+23				

OUTPUT: RISE TIME (NEG. GOING) 1.7 µs
DECAY TIME (POS. GOING) 21. µs
(120 Kc., 14 µµf. plate load, 10 v. Trigger)



Binary Type Input Coupling

Electronic Division
Otis Elevator Company

INPUT	DIODE COUPLING FREQ.	MIN. TRIG.	DUR.	BINARY COUPLING 4.7 μμF FREQ.	MIN. TRIG.	DUR.	200 Kc. TRIGGER (.05 μs. Rise Time) C_c	MIN. TRIG.	DUR.	C_c = 30 μμF PLATE LOAD	MIN. TRIG.
	200 Kc.	2. V.	.6 μs.	200 Kc.	44. V.	.6 μs.	10 μμf.	30 V.	.4 μs.	100 K, 50 μμf.	20 V. (.4 μs. dur.)
	400	2.		400	48.		30	16			15 V. (.8 μs. dur.)
	600	2.		600	54.						
	800	2.		800	66.						
	1 Mc.	2.5		1	80						
	1.2	3.5		1.2	96						
	1.4	4.5		1.4	180						
	1.6	5.5									
	1.8	8.0									
	2	12.									
	4	50.									
	(30 v. plate swing)			(7 μμf. plate load)							

OUTPUT	R_K = 5K #1	#2	R_K = 2K #1	#2	ΔE_F = −10 % #1	#2	ΔE_F = −20 % #1	#2	ΔE_{BB} = −10 % #1	#2	ΔE_{BB} = +10 % #1	#2
FLIP	110	204	98	201	98	202	99	201	87	180	105	220
FLOP	204	114	202	93	201	94	201	94	180	84	220	100
SWING	94	90	104	108	103	108	102	107	93	96	115	120

COMMENTS: Circuit is stable for R_K > 1.5K. Measurements are taken with R_K = 2K unless otherwise indicated.

DATA: (TUBE USED IN TEST)

	#1	#2
G_M	4300	5600

EMISSION WITH 12 K LOAD

E_{BB} = 175 v., E_C = 0 v.

ΔE_F	#1	#2
0	8.3 ma.	8.9 ma.
−10 %	8.0 "	8.5 "
−20 %	7.5 "	8.0 "

EMISSION AS ABOVE TAKEN FROM AVERAGE 6J6 TUBE CHARACTERISTIC 8.7 MA.

CIRCUIT DATA: POWER REQUIREMENTS:

+225 v. Supply 10.2 ma.

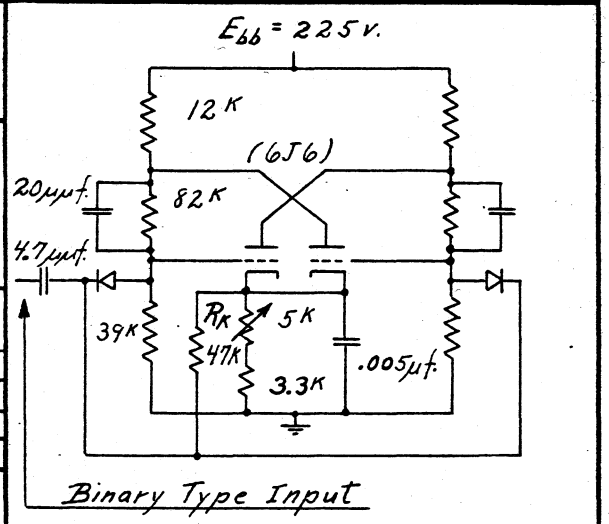
6.3 v. 450. "

GRID AND CATHODE LEVELS	R_K = 5K #1	#2	K	R_K = 2K #1	#2	K
TUBE IN PLACE	62	38	62	47	34	47
	40	62	62	36	46	46
TUBE REMOVED	66			66		
		66			66	

OUTPUT: RISE TIME (NEG. GOING) .2 μs

DECAY TIME (POS. GOING) 1.0 μs

(200 Kc., 14 μμf. plate load, 5 v. Trigger)



Binary Type Input

Use: Binary Counter

Radio Corporation of America

INPUT	DIODE COUPLING FREQ.	MIN. TRIG.	DUR.	CAPACITIVE COUPLING 10 µµF FREQ.	MIN. TRIG.	DUR.	200 Kc. TRIGGER (.05 µs. Rise Time) C_c	MIN. TRIG.	DUR.	C_c = 30 µµF PLATE LOAD	MIN. TRIG.
	20 Kc.	1 v.	.6 µs.	Binary Type Coupling			10 µµf.	27 v.	.5 µs.	100K, 50 µµf.	24 v.
	60	1					30	15	.4	100K, 100 µµf.	86 v.
	100	1		10 Kc.	19. v.	.8 µs.					
	200	1		50	19.						
	400	1.4		80	19.						
	600	2.2	.5	100	20.						
	800	2.6		200	20.						
	1	4.8		400	25.	.6					
	1.6	5.5	.4	600	32.						
	1.8	9.0		800	48.	.4					
	(55v. swing at Output #1)			1 Mc.	66.	.3					

OUTPUT	R_K=5K #1	#2	R_K=0 #1	#2	ΔE_F = -10 % #1	#2	ΔE_F = -20 % #1	#2	ΔE_{BB} = -10 % #1	#2	ΔE_{BB} = +10 % #1	#2
FLIP	195	138	176	101	176	103	177	115	159	93	193	110
FLOP	237	225	237	222	237	223	236	223	214	201	261	245
SWING	42	87	61	121	61	120	59	108	55	108	68	135

COMMENTS: Output #1 and #2 refer to the points shown on the schematic. Tests are made with R_K = 0 except where indicated. Min. Trig. tests made with 14 µµf. load at Output #1

DATA: (TUBE USED IN TEST)

	#1	#2
G_M	4300	5600

EMISSION WITH 12.4K LOAD

E_{BB} = 200 v., E_C = 0 v.

ΔE_F	#1	#2
0	10.1 ma.	10.1 ma.
-10 %	9.7 "	9.7 "
-20 %	9.3 "	9.3 "

EMISSION AS ABOVE TAKEN FROM AVERAGE 6J6 TUBE CHARACTERISTIC 9.7 MA.

CIRCUIT DATA: POWER REQUIREMENTS:

+250 v. Supply (R_K=5K) 10.7 ma. (R_K=0) 13.7 "

6.3 v. " 450. "

GRID AND CATHODE LEVELS	R_K=5K #1	#2	K	R_K=0 #1	#2	K
TUBE IN PLACE	71	45	71	54	32	53
	45	73	73	34	53	52
TUBE REMOVED	73			73		
		74			74	

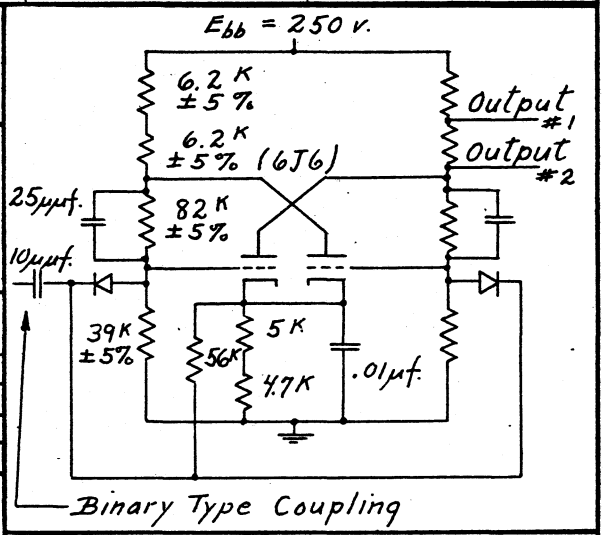
(200 Kc, 14 µµf. load, 5 v. Trigger)

OUTPUT #1 RISE TIME (NEG. GOING) .15 µs

DECAY TIME (POS. GOING) .8 µs

Output #2 Rise Time .13 µs.

Decay Time 1.2 µs.



Use: Binary Counter

Sunvic Controls Ltd.

INPUT	DIODE COUPLING			CAPACITIVE COUPLING 30 μμF			100 Kc. TRIGGER			C_c = 30 μμF
	FREQ.	MIN. TRIG.	DUR.	FREQ.	MIN. TRIG.	DUR.	C_c	MIN. TRIG.	DUR.	PLATE LOAD MIN. TRIG.
	20 Kc.	3. V.	2 μs.	20 Kc.	14. V.	2 μs.	10 μμf.	73. V.	2 μs.	100K, 50μμf. 39V. (2μs. dur.)
	30	3.		30	15.		30	34		
	40	3.5		40	18.		50	23		100K, 100μμf. a 150V. Trigger will not flip the circuit.
	60	4.8		60	23.					
	80	5.2		80	29.					
	100	6.		100	34.					
	150	11.		150	43.					
	200	15.		200	50.					
	300	22.		300	60.					
	400	43.		400	68.					
	500	57.		500	70.					
	600	68.	1 μs.							
	(58 V. plate swing)									

OUTPUT	Nominal #1	Nominal #2	ΔE_F = -10 % #1	ΔE_F = -10 % #2	ΔE_F = -20 % #1	ΔE_F = -20 % #2	ΔE_{BB} = -10 % #1	ΔE_{BB} = -10 % #2	ΔE_{BB} = +10 % #1	ΔE_{BB} = +10 % #2
FLIP	41	137	41	137	42	137	38	121	43	150
FLOP	137	40	137	40	137	41	121	37	150	42
SWING	96	97	96	97	95	96	83	84	107	108

COMMENTS:

DATA: (TUBE USED IN TEST)

	#1	#2
G_M	2300	2350

EMISSION WITH 20 K LOAD

E_{BB} = 150 v., E_C = 0 v.

ΔE_F	#1	#2
0	5 ma.	5 ma.
-10 %	4.9 "	4.9 "
-20 %	4.8 "	4.8 "

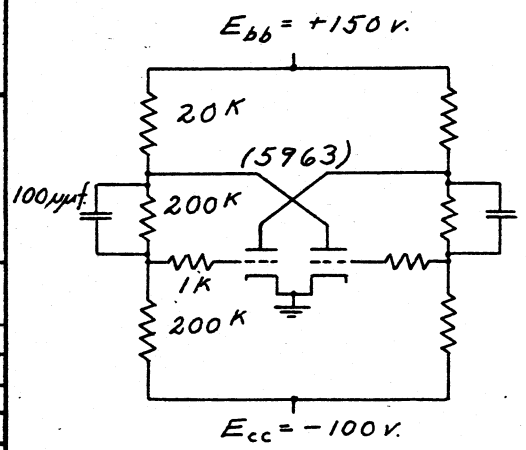
EMISSION AS ABOVE TAKEN FROM AVERAGE 5963 TUBE CHARACTERISTIC 5.0 MA.

CIRCUIT DATA: POWER REQUIREMENTS:

+150 v. Supply 6.5 ma.
-100 v. " .9 "
6.3 v. " 300. "

GRID AND CATHODE LEVELS	#1	#2	K	#1	#2	K
TUBE IN PLACE	+.4	-30	0			
	-29	+.4	0			
TUBE REMOVED	+20					
		+19				

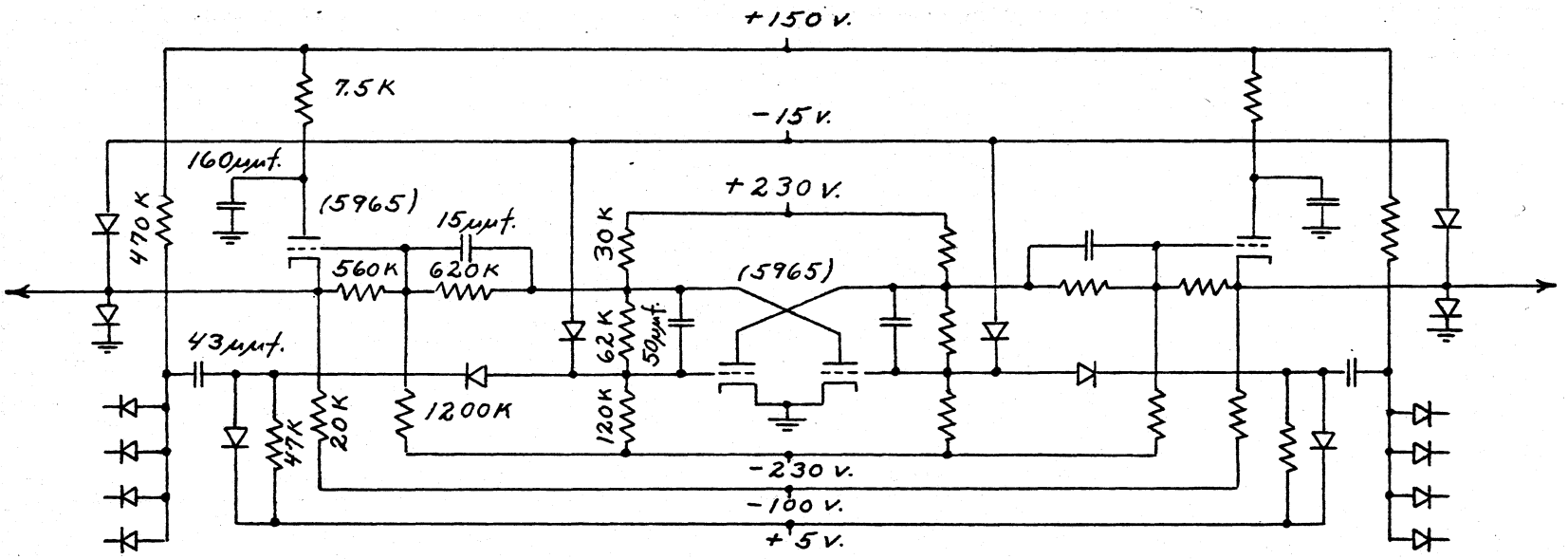
OUTPUT: (100 Kc, 14 μμf. plate load, 10 v. Trigger)
RISE TIME (NEG. GOING) .3 μs
DECAY TIME (POS. GOING) 3.5 μs

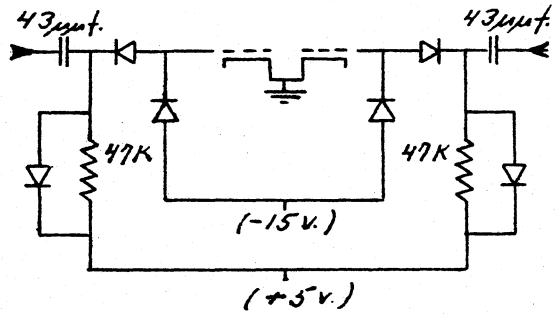


Resistor tol. ± 5%

TC-0001 Trigger

Telecomputing Corporation





COUPLING AS SHOWN AT LEFT

Freq.	Min. Trig.	Dur.
20 Kc.	11 v.	1 μs.
40	11.8	
70	12.	
100	13.	
200	15.	
300	18.	
400	22.	
600	33.	
800	43.	
1 Mc.	53.	

INPUT	DIODE COUPLING FREQ.	MIN. TRIG.	DUR.	CAPACITIVE COUPLING 30 μμF FREQ.	MIN. TRIG.	DUR.	100 Kc. TRIGGER C_c	MIN. TRIG.	DUR.	C_c = 30 μμF PLATE LOAD	MIN. TRIG.
	20 Kc.	2.8 v.	1 μs.	20 Kc.	14. v.	1 μs.	10 μμf.	32 v.	1 μs.	100K, 50 μμf.	50 v. (1 μs. dur.)
	40	3.2		40	14.		30	14		100K, 100 μμf.	52 v. (1 μs. dur.)
	70	3.8		70	14.		50	11			49 v. (2 μs. dur.)
	100	4.6		100	14.						
	200	8.4		200	15.						
	300	13.		300	16.						
	400	19.		400	19.						
	600	31.		600	25.						
	800	46.		800	27.						
	1 Mc.	62.		1 Mc.	28.						
	← (70 v. plate swing)										

OUTPUT	Diodes Removed #1	#2	Nominal #1	#2	ΔE_F = −10 % #1	#2	ΔE_F = −20 % #1	#2	ΔE_{BB} = −10 % #1	#2	ΔE_{BB} = +10 % #1	#2
FLIP	32	154	33	153	34	153	35	153	34	137	34	166
FLOP	154	30	154	31	154	31	153	32	138	32	167	31
SWING	122	124	121	122	120	122	118	121	104	105	133	135

COMMENTS: For additional input coupling method and complete schematic as given by the Mfg. see reverse side of data sheet.

DATA: (TUBE USED IN TEST)

	#1	#2
G_M	7250	7100

EMISSION WITH 30 K LOAD

E_{BB} = 230 v., E_C = 0 v.

ΔE_F	#1	#2
0	6. ma.	5.8 ma.
−10 %	5.8 "	5.5 "
−20 %	5.6 "	5.3 "

EMISSION AS ABOVE TAKEN FROM AVERAGE 5965 TUBE CHARACTERISTIC 5.8 MA.

CIRCUIT DATA: POWER REQUIREMENTS:

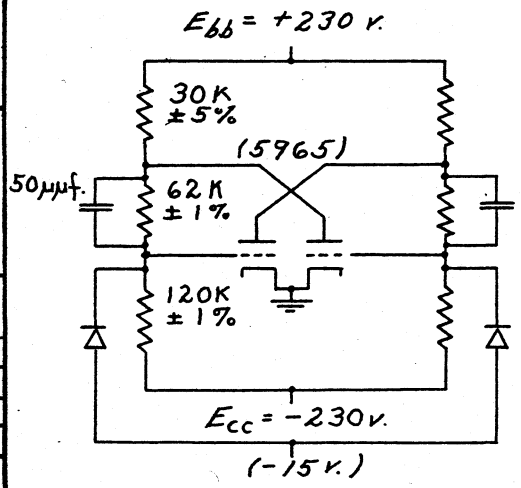
+230 v. Supply	9.4 ma.	
−230 v. "	3.4 "	
6.3 v. "	450. "	

GRID AND CATHODE LEVELS	#1	#2	K	Diodes Removed #1	#2	K
TUBE IN PLACE	0	−15	0	0	−57	0
	−15	0	0	−55	0	0
TUBE REMOVED	+33			+34		
		+26			+33	

OUTPUT: RISE TIME (NEG. GOING) .46 μs

DECAY TIME (POS. GOING) 3.5 μs

(100 Kc., 14 μμf. plate load, 10 v. Trigger)



Telecomputing Corporation

Binary Type Input		
Freq.	Min. Trig.	Dur.
5 Kc.	68 v.	1 μs.
10	68	
20	68	
40	68	
60	68	
80	72	
100	72	
200	90	
300	120	

INPUT	DIODE COUPLING			CAPACITIVE COUPLING 30 μμF			200 Kc. TRIGGER			C_c = 30 μμF
	FREQ.	MIN. TRIG.	DUR.	FREQ.	MIN. TRIG.	DUR.	C_c	MIN. TRIG.	DUR.	PLATE LOAD MIN. TRIG.
	20 Kc.	1.4 v.	1 μs.	20 Kc.	5.0 v.	1 μs.	10 μμf.	17. v.	1 μs.	100K, 50 μμf. 16. v. (1 μs. dur.)
	30	1.6		30	4.4		30	9.5		100K, 100 μμf. 26 v. (1 μs. dur.)
	40	1.6		40	4.7		50	8.0		100K, 185 μμf. 64 v. (1 μs. dur.)
	50	2.0		60	4.8					
	60	2.0		80	5.4					
	80	2.0		100	5.4					
	100	2.0		200	9.5					
	200	2.0		300	18.					
	300	2.2		400	28.					
	400	2.6		500	36.					
	500	3.4		600	41.					
	600	4.0		800	40.					
	800	20.0								
	(56 v. plate swing)									

OUTPUT	Nominal #1	Nominal #2	ΔE_F = −10 % #1	ΔE_F = −10 % #2	ΔE_F = −20 % #1	ΔE_F = −20 % #2	ΔE_{BB} = −10 % #1	ΔE_{BB} = −10 % #2	ΔE_{BB} = +10 % #1	ΔE_{BB} = +10 % #2
FLIP	27	131	27	131	27.5	131	25	118	29	143
FLOP	131	27	131	27.5	131	27.5	118	25.5	143	29
SWING	104	104	104	103.5	103.5	103.5	93	92.5	114	114

COMMENTS: For Binary type coupling see reverse side of data sheet.

DATA: (TUBE USED IN TEST)

	#1	#2
G_M	6000	6000

EMISSION WITH 55 K LOAD

E_{BB} = 240 v., E_C = 0 v.

ΔE_F	#1	#2
0	3.5 ma.	3.5 ma.
−10 %	3.4 "	3.4 "
−20 %	3.3 "	3.3 "

EMISSION AS ABOVE TAKEN FROM AVERAGE 5670 TUBE CHARACTERISTIC 3.4 MA.

CIRCUIT DATA: POWER REQUIREMENTS:

+250 v. Supply 6.0 ma.

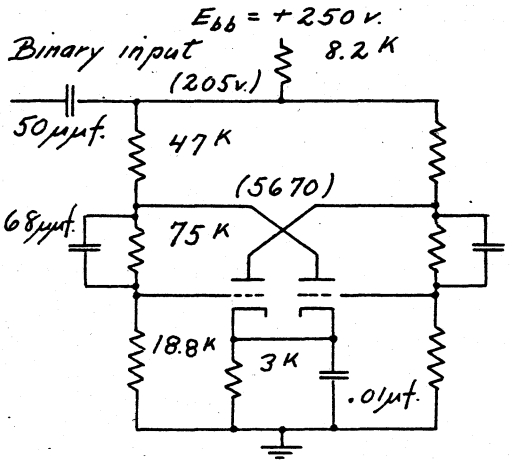
6.3 v. " 350. "

GRID AND CATHODE LEVELS	#1	#2	K	#1	#2	K
TUBE IN PLACE	13.5	5	12.5			
	5	13.5	12.5			
TUBE REMOVED	29					
		29				

OUTPUT: RISE TIME (NEG. GOING) .4 μs

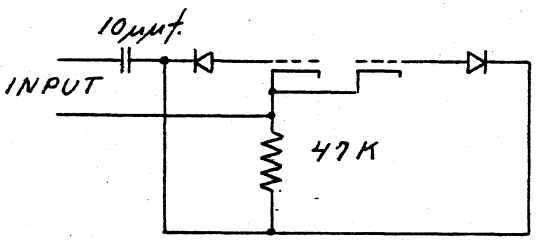
DECAY TIME (POS. GOING) 4.0 μs

(200 Kc., 14 μμf plate load, 5 v. Trigger)



M1673 200 Kc. Counter

Walkirt Company



BINARY TYPE COUPLING		
FREQ.	MIN. TRIG.	DUR.
10 Kc.	15. V.	1 μs.
40	15.	
70	15.	
100	15.	
200	16.	
400	19.	
500	21.	
700	26.	
1	43.	
1	32	.5μs.
1.4	50	
1.6	64	
1.8	92	
1.9	100	

INPUT	DIODE COUPLING FREQ.	MIN. TRIG.	DUR.	CAPACITIVE COUPLING 30 µµF FREQ.	MIN. TRIG.	DUR.	200 Kc. TRIGGER C_c	MIN. TRIG.	DUR.	C_c = 30 µµF PLATE LOAD	MIN. TRIG.
	20 Kc.	2.4 v.	1 µs.	20 Kc.	9. v.	1 µs.	10 µµf.	18. v.	1 µs.	100K, 50 µµf.	18 v. (1 µs. dur.)
	40	2.4		40	9.2		30	10.2		100K, 100 µµf.	46 v. (1 µs. dur.)
	70	2.5		70	9.2		50	8.0			
	100	3.		100	9.4						
	200	6.		200	10.2						
	400	11.		400	11.						
	600	17.		600	14.						
	800	21.		800	14.						
	1 Mc.	24.		1 Mc.	16.						
	1.5	28.	.5 µs.	1.5	20.	.6 µs.					
	2	62.		2	22.						

(92 v. plate swing)

OUTPUT	Nominal #1	Nominal #2	ΔE_F = −10 % #1	ΔE_F = −10 % #2	ΔE_F = −20 % #1	ΔE_F = −20 % #2	ΔE_{BB} = −10 % #1	ΔE_{BB} = −10 % #2	ΔE_{BB} = +10 % #1	ΔE_{BB} = +10 % #2
FLIP	81	212	81	212	82	212	74	192	87	234
FLOP	212	84	212	85	212	86	191	77	233	91
SWING	131	128	131	127	130	126	117	115	146	143

COMMENTS: For Binary type input coupling see reverse side of data sheet.

DATA: (TUBE USED IN TEST)

	#1	#2
G_M	6000	6000

EMISSION WITH 15 K LOAD

E_{BB} = 220 v., E_C = 0 v.

ΔE_F	#1	#2
0	9. ma.	9 ma.
−10 %	8.7"	8.7"
−20 %	8.4"	8.4"

EMISSION AS ABOVE TAKEN FROM AVERAGE 5670 TUBE CHARACTERISTIC 8.8 MA.

CIRCUIT DATA: POWER REQUIREMENTS:

+250 v. Supply 14.0 ma.

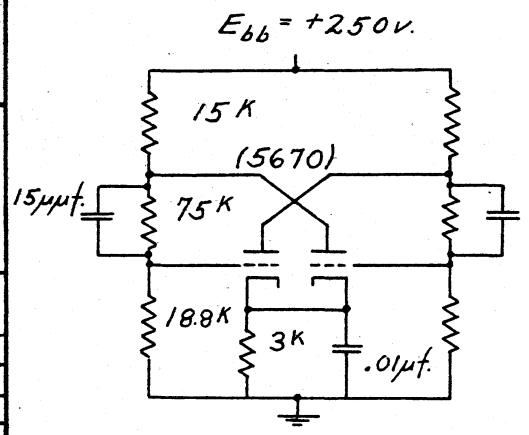
6.3 v. " 350. "

GRID AND CATHODE LEVELS	#1	#2	K	#1	#2	K
TUBE IN PLACE	33	16.5	32			
	16	33	32			
TUBE REMOVED	42					
		42				

OUTPUT: RISE TIME (NEG. GOING) .15 µs

DECAY TIME (POS. GOING) 1.2 µs

(200 Kc., 14 µµf. plate load, 10 v. Trigger)



M 1553 2Mc. Counter

Walkirt Company

INPUT	DIODE COUPLING FREQ.	MIN. TRIG.	DUR.	CAPACITIVE COUPLING 30 µµF FREQ.	MIN. TRIG.	DUR.
	20 Kc.	1.6 v.	1 µs.	20 Kc.	24. v.	.8 µs.
	60	1.6		60	24.	
	100	1.6		100	24.	
	200	2.0		200	28.	
	400	2.8	.8 µs.	400	36.	.6 µs.
	600	3.8	.6 µs.	600	40.	
	800	5.2	.5 µs.	800	46.	
	1 Mc.	6.0				
	1.6	30.		800	76	.5 µs.
	(54 v. plate swing)					

200 Kc. TRIGGER

C_G	MIN. TRIG.	DUR.
10 µµf.	48. v.	.8 µs.
28	22	.6
30	34	2.0

C_c = 30 µµF

PLATE LOAD	MIN. TRIG.
100K, 50 µµf.	54 v. (1.2 µs. dur.)
100K, 100 µµf.	62 v. (1.5 µs. dur.)

OUTPUT	Nominal #1	Nominal #2	ΔE_F = -10 % #1	ΔE_F = -10 % #2	ΔE_F = -20 % #1	ΔE_F = -20 % #2	ΔE_{BB} = -10 % #1	ΔE_{BB} = -10 % #2	ΔE_{BB} = +10 % #1	ΔE_{BB} = +10 % #2
FLIP	46	133	47	133	48	133	43	119	50	146
FLOP	133	44	133	44	133	45	120	40	146	45
SWING	87	89	86	89	85	88	77	79	96	101

COMMENTS:

DATA: (TUBE USED IN TEST)

	#1	#2
G_M	4300	5600

EMISSION WITH 10 K LOAD

E_{BB} = 150 v., E_C = 0 v.

ΔE_F	#1	#2
0	8.1 ma.	8.6 ma.
-10 %	7.7 "	8.2 "
-20 %	7.1 "	7.7 "

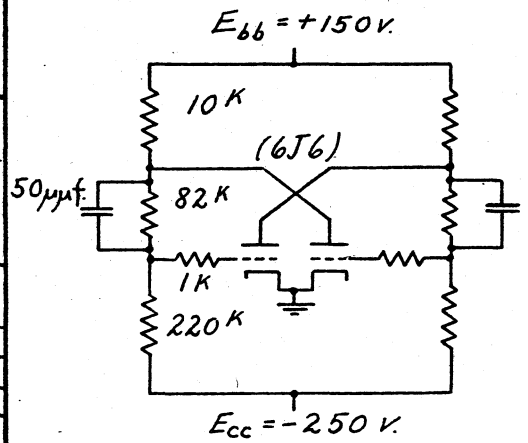
EMISSION AS ABOVE TAKEN FROM AVERAGE 6J6 TUBE CHARACTERISTIC 8.2 MA.

CIRCUIT DATA: POWER REQUIREMENTS:

+150 v. Supply 12 ma.
-250 v. " 2.2 "
6.3 v. " 450. "

GRID AND CATHODE LEVELS	#1	#2	K	#1	#2	K
TUBE IN PLACE	+.6	-34	0			
	-31	+.7	0			
TUBE REMOVED	+36					
		+37				

OUTPUT: RISE TIME (NEG. GOING) .4 µs
DECAY TIME (POS. GOING) 1.0 µs
(200 Kc., 14 µµf. plate load, 5 v. Trigger)



Resistors are 10% matched to 1.5%

Used in: "WISC"

University of Wisconsin